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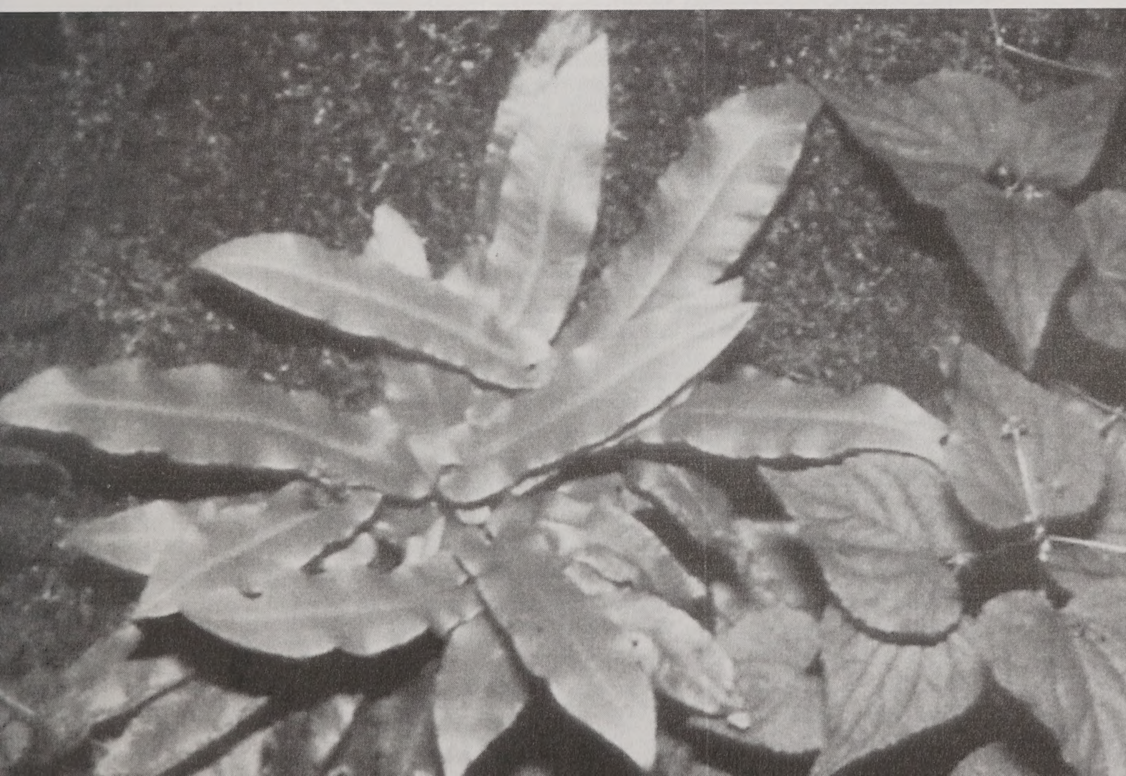

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Membership is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State and the Great Lakes area in general, both in the USA and in Canada; sponsorship of legislation to promote the preservation of Michigan's native flora; establishment of suitable sanctuaries and natural areas, and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

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REDISCOVERY OF PLANTAGO CORDATA (PLANTAGINACEAE) IN MICHIGAN

Bruce D. Parfitt
Biology Department
University of Michigan—Flint
Flint, Michigan 48502-1950

Plantago cordata Lam. previously ranged from Ohio and southern Ontario to Wisconsin and Missouri, and occurred more locally in New York,Virginia, North Carolina, Georgia, and Alabama. In the 1800s, *P. cordata* was considered frequent in central and southern Michigan (Wheeler & Smith 1881). The species had been reported from Clinton, Genesee, Ionia, Macomb, and Tuscola counties (Wheeler & Smith 1881; Beal 1904) and Oakland County [as "reported by Stacy" (Bingham 1945)]. In addition, Voss (1996) mapped specimens from Eaton, Gratiot, Kent, St. Clair, Shiawasee, Washtenaw, and Wayne counties. Except for two Washtenaw County specimens collected in 1924 and 1925, all were from the 1800s, the earliest being an 1838 specimen from St. Clair County.

By the twentieth century the species was rare, presumably as a result of habitat loss. From 1925 to 1990, *P. cordata* was not seen by botanists in Michigan. Today its status in the state is "Threatened" with a rank of "S1," which indicates it is critically imperiled because of five or fewer occurrences or very few remaining individuals (Anonymous 1992). In North America the species is now considered rare (Gleason and Cronquist 1991), or very rare and local throughout its range (G3, Anonymous 1992), though more widespread or abundant than previously thought. *Plantago cordata* is not listed as Threatened or Endangered by the United States Fish and Wildlife Service.

In 1990 *Plantago cordata* was rediscovered by W. H. Wagner and P. Fritsch in Hillsdale County (Voss 1996). The population consists of over 600 juvenile and 205 mature individuals occupying an area about 6 × 30 m. A second Michigan population of about 500 individuals was discovered by F. & R. Case in 1995 in Ionia County (Voss 1996). Both sites are documented by specimens in MICH.

While engaged in a floristic study of the eastern portion of Tuscola State Game Area during spring of 1997, Debra Bassett and Elizabeth Kohan independently discovered populations of *Plantago cordata* in Tuscola County. The following year, 1998, Parfitt, Elizabeth Kohan, Nan Kelly, and Charles A. Wade returned to study and map the populations, and to seek additional populations.

Mapping of the two Tuscola County sites of *Plantago cordata* using a global positioning system (GPS) revealed them to be parts of one large, nearly contiguous population. Although the population was clearly centered on an ephemeral stream, outlying clusters of plants were also found in the very wet deciduous woods and in the flooded ruts of an old, now rarely used vehicle-access trail (locally called a "two-track"). I speculate that such a dispersal from the stream occurred as a result of major flooding in June (fruiting time), 1996. Although the

Tuscola State Game Area has much similar habitat, including other ephemeral streams, searches for additional sites with *P. cordata* were not successful.

The Tuscola County population is nearly contiguous along nearly 0.6 km (about 1/3 mile) of ephemeral stream. The large size of the Tuscola County population precluded counting all individuals. Also, because of the inaccuracy of GPS readings, we could not obtain a precise measurement of the area occupied by *P. cordata.* A conservative estimate by field workers Wade, Kelly, and Kohan suggests there may be more than 4000 individuals of *P. cordata* in the population.

The Tuscola County population is the third extant population to be discovered in Michigan, and is more than 125 kilometers from the nearest known extant population. It is also the northernmost Michigan population. The other two populations are considerably smaller.

Diagnostic Characters. In spring (April and early May) young plants are so small as to resemble *Plantago major* L. or *P. rugelii* Decne. Characteristics that distinguish *P. cordata* from the other species are its stream or wet swamp habitat (instead of moist to dry places), glabrous inflorescence and leaves (instead of often pubescent), fleshy roots (instead of fibrous), May flowering time (instead of June—August), and tender succulent petioles (instead of tough and stringy). By June, plant size alone should be sufficient for identification, with fruiting spikes of *P. cordata* to 6 dm tall with leaves 5 dm or more in length.

MICHIGAN. TUSCOLA CO.: Eastern portion of the Tuscola State Game Area (precise data withheld at the request of the Natural Features Inventory, Michigan State University Extension); [swamp/marsh margin], emergent in standing (or slightly flowing) water, April 1997, *Debra Bassett 150 & Karen Gould,* (MICH, UMF); swamp, 10 May 1997, *Bruce D. Parfitt 5787 & Elizabeth G. Kohan* (MICH, UMF); swamp along stream north of open marsh, 29 May 1998, *Bruce D. Parfitt 6018* with *Nan Kelly & Charles A. Wade,* (MICH, OSH, UMF).

ACKNOWLEDGMENTS

Special thanks to Nan Kelly and Charles A. Wade for running transects and plots, and to Elizabeth G. Kohan, Derrick Townsend, Debra Bassett, Karen Gould, and Star Shelton for many hours of field work leading to this discovery.

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BRYOPHYTES ASSOCIATED WITH HART'S TONGUE FERN (*ASPLENIUM SCOLOPENDRIUM* VAR. *AMERICANUM*) ON DOLOMITE ROCKS IN MACKINAC COUNTY, MICHIGAN

Janice M. Glime

Department of Biological Sciences
Michigan Technological University
Houghton, MI 49931
jmglime@mtu.edu

ABSTRACT

Nineteen bryophyte taxa were found within the circle of influence of the hart's tongue fern. These formed zonation patterns on individual rocks, with pleurocarpous mosses such as *Thuidium recognitum*, *Anomodon attenuatus*, *Brachythecium* spp., and *Plagiomnium affine* predominating. One- and two-year-old fern sporophytes were found in disturbed patches where the thick moss mats were missing and only a thin layer of young mosses, fern and moss rhizoids, and detritus covered the rock. Older sporophytes occurred predominantly on the sides of rocks where they were supported by thick mats of mosses.

INTRODUCTION

Asplenium scolopendrium Linnaeus var. *americanum* (Fernald) Kartesz & Gandhi is federally listed as threatened in the United States, with over 90% of the individuals occurring in only two counties of central New York (Cinquemani Kuehn & Leopold 1992). Known also as *Phyllitis scolopendrium* (Linnaeus) Newman var. *americanum* Fernald, the hart's tongue fern, it grows in small populations on dolomite rocks of the Engadine series in Mackinac County, Michigan, where it is protected by U. S. Forest Service ownership. The dolomite series has both Mg and Ca, providing an essential blend of nutrients that permit plants to grow (U.S. Fish and Wildlife Service, Division of Endangered Species, 1990), whereas many other kinds of limestone rocks are lacking in some essential nutrient.

The hart's tongue-bearing rocks of this series are covered with bryophytes, whereas in New York Cinquemani Kuehn and Leopold (1993) found that the mature plants more typically were on bryophyte-poor rocks. Because little is known about the ecology of the Michigan hart's tongue populations, it is desirable to understand their association with these bryophytes. It is possible that the bryophytes provide some necessary aspect to the microhabitat of these endangered ferns. And because shaded dolomite boulders are themselves an uncommon occurrence in Michigan, it is also likely that these boulders provide a unique environment for bryophytes. It is the purpose of this study to determine the bryophytes associated with the hart's tongue fern and to examine possible re-

lationships they might have with the fern as an indication of topics needing further study in the quest to protect these endangered plants.

METHODS

In July 1993, we visited two hart's tongue fern sites (Taylor Creek and East Lake, Mackinac County, MI), guided by Dorothy Evans of the U. S. Department of Agriculture, Forest Service, Escanaba, MI, and compiled a species list for the bryophytes. Our primary objective was to determine what comprised the typical communities and to examine the rocks for unusual bryophytes. At the same time, we looked for clues as to any possible role the bryophytes might play in the success of the fern, particularly in the gametophyte stage.

We sampled 21 plots at East Lake and 39 plots at Taylor Creek. Whenever possible, we re-located the plots previously marked and numbered for the fern study by staff of the Forest Service, Escanaba, MI. Plots consisted of a radius of influence of ca. 15 cm. In addition, we listed any species seen but not within the circle of influence. Since the ferns were almost exclusively on the sides of boulders, mosses occurring on the tops of the boulders were outside the circle of influence, but all of these appeared at some location within the circle of influence around a hart's tongue fern.

Nomenclature follows Anderson *et al.* (1990) for mosses, Crum (1991) for liverworts, and Flora of North America Editorial Committee (1993) for ferns. Voucher specimens of bryophytes are deposited in the cryptogamic herbarium of Michigan Technological University (MCTC) and with the U.S. Department of Agriculture, Forest Service, Escanaba, MI.

RESULTS AND DISCUSSION

Bryophyte associations

Nineteen species of bryophytes were found in association with the hart's tongue fern on the boulders. Seventeen were present at East Lake; eleven were present at Taylor Creek (Table 1). Seven species that occurred on only one or two rocks in association with ferns at East Lake were absent from Taylor Creek despite the larger number of samples there; only two species from Taylor Creek were present in only one or two associations and absent from East Lake. Thus, nine abundant species were common to both sites.

Most of the rocks were completely covered by bryophytes, with only small areas of recent disturbance that provided areas of exposed rock. Several species dominated the rocks: *Anomodon attenuatus, Brachythecium rutabulum, Brachythecium* sp., *Plagiomnium affine, Thuidium recognitum.* Only *Anomodon attenuatus* (12% of NY samples collected) was in common with the dominant bryophytes in the New York study (Cinquemani Kuehn & Leonard 1993), which together with *Brachythecium oxycladon* (Brid.) Jaeg. & Sauerb. (42%), *Mnium cuspidatum* Hedw. (24%), and *Eurhynchium pulchellum* (Hedw.) Jenn. (12%) comprised the most common NY taxa. Since all of these taxa are common in this geographic area, the overlap of only one common species suggests that conditions most likely are different.

Plagiothecium laetum was common in a narrow zone at the bases of rocks, especially at Taylor Creek. Examination under the microscope revealed several taxa that were not seen in the field: *Platydictya confervoides, Homalia trichomanoides, Lophozia barbata.* The development of a species list was compli-

TABLE 1. Percent frequency of bryophyte species from circle of influence plots at East Lake (21 plots) and Taylor Creek (39 plots).

	East Lake	Taylor Creek
Anomodon attenuatus (Hedw.) Hüb.	33	33
Anomodon rostratus (Hedw.) Schimp.		5
Barbilophozia barbata (Schreb.) Loeske	10	
Brachythecium shiny	71	59
Brachythecium rutabulum (Hedw.) Schimp. in B.S.G.	33	31
Cephalozia sp.	5	
Cephaloziella rubella (Nees) Warnst.	5	
Dicranum scoparium Hedw.	5	
Fissidens adianthoides Hedw.	19	13
Homalia trichomanoides (Hedw.) Schimp in B.S.G.	5	
Mnium marginatum (With.) Brid. ex P. Beauv.	10	21
Plagiochila porelloides (Torr.) Lindenb.	10	
Plagiomnium affine (Bland. ex Funck) T. Kop. *sensu lato*	14	74
Plagiothecium laetum Schimp. in B.S.G.	19	44
Platydictya confervoides (Brid.) Crum	5	
Porella platyphylla (L.) Pfeiff.		3
Rhodobryum ontariense (Kindb.) Par. in Kindb.	14	10
Thuidium recognitum (Hedw.) Lindb.	57	46
Tortella tortuosa (Hedw.) Limpr.	5	

cated by the low light at the sites and the restrictions on collecting that were necessary in order to protect the fern sites for future expansion. It is likely that other small taxa, especially leafy liverworts, were not located.

The bryophytes seem to exhibit a zonation pattern that is worthy of further study. The tops of the rocks and a considerable distance down the sides are covered by *Brachythecium rutabulum* and a second undetermined species that appears to be a different, smaller, shiny *Brachythecium*. On some rocks, the top is covered instead by *Thuidium recognitum*. Below that is a zone of *Anomodon attenuatus*. Near the bases of many of the rocks there is a narrow band of *Plagiothecium laetum*. The hart's tongue fern seems to be concentrated in the middle and bottom zones.

Patchiness

Fissidens adianthoides and *Mnium marginatum* tend to occur as invaders in disturbed patches where large clumps of the dominant pleurocarpous mosses such as *Brachythecium*, *Thuidium*, *Plagiomnium*, and *Anomodon* have been torn off. Kimmerer & Allen (1982), studying disturbed patches of sandstone cliffs, observed similar patterns for *Fissidens obtusifolius* where large, intertwined bryophytes had been torn off. As on the boulders, the dominant cliff species occurred in distinct vertical zones, whereas all species had a patchy distribution on open spaces that had resulted from disturbance. *Fissidens obtusifolius* had the greatest cover in the low, most disturbed cliff zone, whereas *Conocephalum conicum* was virtually absent there. Kimmerer & Allen concluded that its absence was due to severe disturbance, where large, intertwined, weakly attached patches

were removed as a group. The smaller, upright *Fissidens*, on the other hand, had individual plants strongly attached by rhizoids and was not intermingled, therefore not losing large masses at one time. In undisturbed areas, *F. obtusifolius* was easily overgrown by *C. conicum*. In more stable areas, *Gymnostomum aeruginosum* and *Mnium marginatum* occurred in the same zones as the *Conocephalum*, but they were not dominants. On the dolomite boulders of the present study, as with *C. conicum*, when any part of the larger pleurocarpous mosses is detached, it is likely to take with it a large portion of the adjoining clone.

Establishment of *F. obtusifolius* in areas of disturbance can occur within 30 days, but the percent cover drops to less than 10% within one year (Kimmerer & Allen 1982). At the dolomite boulders, it is likewise a species of *Fissidens, F. adianthoides*, that is the primary invader of disturbed patches. Likewise, in some of these, *Mnium marginatum* is a common invader, occurring only where the thick moss mats had detached. The one large mat-forming species that enters early in this post-disturbance succession is *Thuidium recognitum*, but in its early stages of development it has a growth form not very different from that of the *Fissidens* or *Mnium*. On the sandstone cliffs, the *Fissidens* was not replaced with *Fissidens*, but rather by a group of intermediate successional species: *Brachythecium rutabulum* increased sixfold and *Gymnostomum aeruginosum* increased threefold (Kimmerer & Allen 1982). It was not clear which of the pleurocarpous mosses invaded next on the limestone boulders, but it appeared that the most likely event was invasion by the existing mosses at the periphery of the disturbance patch.

Interaction of fern and bryophytes

Both the young sporophytes and the mature sporophytes of the ferns were attached to the sides of the bryophyte-covered boulders. On one or two occasions we found mature sporophytes on the ground in a clump of mosses that apparently had fallen from the adjacent rock. The mosses were typical of the mosses on the rock and were generally not abundant on the soil.

It does not appear that the species of bryophyte within our study sites are important to the ferns, but the stage of succession may be. We were able to find several colonies of young sporophyte fern leaves that appeared to be first-year plants, although we were unable to see any gametophytes to verify this (Fig. 1). These were concentrated very close to the bottom of the rocks, near and below mature plants. It appeared that, without exception, these had close contact with the rock surface, although in all cases some sort of primary cover existed. Often this cover was a thin (ca. 1 mm) growth of very young *Thuidium recognitum, Mnium marginatum, Plagiomnium affine,* and *Fissidens adianthoides*. In some cases, it seemed to be a thin felt of fern roots, moss rhizoids, or other brown material including detritus. When we tried to examine these young sporophytes with a hand lens, there was no way to avoid blocking our own light, thus making it nearly impossible to determine if any gametophyte tissue remained. By late July, it is likely that most of the gametophytes would already be dry and withered away. The important observation is that these young sporophytes occurred where the bulky bryophyte cover had been removed by disturbance and

FIGURE 1. *Asplenium scolopendrium* first-year sporophyte (left) and another several years old (right) with invading mosses on a felt of rhizoids and detritus left behind by a disturbed moss mat. Note the thicker moss mat at right, which is able to support the developing fern rhizome.

there was access to the rock substrate. The moss mat was too thick for either gametophytes or sporophytes to succeed on the rock at the base of the mat. Although we looked on every rock that had mature ferns, we were unable to locate any young fern sporophytes or gametophytes on the thick bryophyte mats.

It is possible that the hart's tongue, like *Hymenophyllum* in the southern Appalachians (Hicks 1979), has a life cycle in which the gametophyte has a different optimal habitat from that of the sporophyte. It appears that the hart's tongue requires disturbance that removes the thick moss mat in order for the gametophyte to become established, but that the mature sporophyte may require the support of the mosses to remain positioned on the sides of rocks. Hence, the bare patch must be of the right size for its surrounding bryophytes to grow in concert with the fern sporophyte and offer support at just the right time when the sporophyte rhizome is too heavy to cling to the rock without that support.

In this remote Michigan forest site, there are few sources of disturbance. The location of disturbed patches near the bottom and on the sides of the rocks may be the result wildlife activity or of patches of heavy snow or ice that fall as a chunk, carrying with them the bryophytes frozen into the mass. The frequency of disturbed patches, however, is small, and the patches likewise are small, making it possible for the large mats to invade easily and support the heavy rhizomes as they mature.

Futyma (1980) found that *A. scolopendrium* mature plants were typically as-

sociated with bryophytes in his Michigan plots. On the other hand, Cinquemani Kuehn and Leopold (1993) had quite different results in New York. They found that cover of mature *A. scolopendrium* was negatively correlated ($r=-0.206$, $P<0.05$) with bryophyte cover but that immature *A. scolopendrium* was positively correlated ($r=0.425$, $P<0.05$). Sporelings were predominantly on bryophyte-covered rocks (79.9%) but only 46.0% of immature and 8.8% of mature *A. scolopendrium* were associated with bryophytes. One possible interpretation is that where mature *A. scolopendrium* is present, the bryophyte cover is reduced by competition with the ferns for substrate, but Silvertown (1983) contends that competitive exclusion and niche separation are not important in limestone pavement habitats because of the occurrence of the plants "in discrete compartments which give clear limits to possible niches." Furthermore, competition would not account for the remainder of the rock being bare, as in the New York study. Rather, in the New York study it appears that crevices with organic matter were most important for mature plants, perhaps relating to nutrient value of the rocks. The differences in dominant bryophyte species between New York and Michigan may indicate the distinctions here—could it be that the New York bryophyte taxa were less conducive to fern growth, or are they merely indicative of differences in substrate chemical and physical properties that likewise affect the preference of the ferns for bare rock?

From the New York study, we know that bryophytes, slope position, canopy openings, herbaceous plant cover, shrub cover, deciduous vs conifer cover, and rock crevices all are important determinants of the success of *A. scolopendrium* (Cinquemani Kuehn & Leopold 1993). If at the New York site the canopy cover was less and moisture conditions less than in the Michigan sites, bryophyte cover may have been needed to protect the young plants from desiccation and/or excess light, whereas the mature plants required access to crevices for both nutrients and water. Bodziarczyk (1992) found that the European variety of *A. scolopendrium* has a negative correlation with light intensity and suggested that forest floor herbs could play a significant role in protecting the young plants from high light intensity. By contrast, Cinquemani Kuehn and Leopold (1993) found that sporelings at their New York site had a positive correlation with light intensity, but they did suggest that during drought the sporelings with higher light intensities might be injured by the concomitant higher temperatures and evaporation. Temperature for germination, on the other hand, seems less critical, assuming that the spores germinate before the onset of summer heat. Pangua *et al.* (1994) determined experimentally that spores germinated equally successfully at 10, 15, 20, and 25°C. Measurements of these and other microhabitat parameters for Michigan populations are clearly needed.

As in any study with threatened taxa, it is difficult to experiment to find the best or necessary growing conditions without risking a negative impact on the plants you are trying to protect. The Michigan populations are too small to withstand such risk. Although several of the New York populations are sufficiently large, the conditions there are clearly different, and it is likely that the Michigan populations will prove to be genetically distinct. Based on the findings of this preliminary study, there are several observations in addition to microclimate

monitoring that need to be developed as testable hypotheses and that could conceivably be studied without endangering the populations:

The bryophytes may exhibit a vertical zonation on the rocks that is related to light and moisture availability.

New (for the Upper Peninsula of Michigan) or rare bryophyte taxa for the state of Michigan may occur on the dolomite boulders in other locations in the region.

Disturbance of the bryophyte cover is likely to play a major role in the spread by spores of *Asplenium scolopendrium*.

Bryophytes may provide the support necessary to maintain the position of the mature fern on the side of a boulder.

Taxa of bryophytes associated with the fern gametophyte may be different from those associated with the sporophyte.

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BOOK REVIEW

Of Frankenfoods and Golden Rice. Risks, Rewards, and Realities of Genetically Modified Foods. Buttel, Frederick H. And Robert M. Goodman, editors. Transactions of the Wisconsin Academy of Sciences, Arts and Letters 89: iii +147. 2001. Paperback, ISSN 0084-0505. $8 + $2.50 postage and handling; Wisconsin Academy, 1922 University Avenue, Madison, Wisconsin 53705.

This is a complete volume of a venerable Wisconsin journal, whose first volume was published in 1872. It is, however, utterly unlike its 88 predecessor volumes, which were devoted to such topics as "Preliminary Reports on the Flora of Wisconsin," "The Beowulf Legend," and exegesis of poetry, among many other things. With this volume, the decision was taken to print what amounts to a free-standing book on a single topic, comprised of papers given at the Academy's Fall Forum 2000, amplified with reprinted papers from a variety of other sources.

Victor Frankenstein in the original novel was a student who worked to produce a living being unlike anything to be found in nature. He had no degree and no laboratory assistant, Igor; these things are the invention of movie-makers. Indeed, when the nameless monster came to life, the student experimenter was horrified at what he had wrought. I take the term "Frankenfoods" to be based on the movie notion of "Dr. Frankenstein." The term is an evocative one, suggesting the creation of things not found in nature—but I have no idea who originated the neologism.

The entire subject of genetically modified foods has become a very emotional and charged issue. I find it hard to see why. Moving genes from one organism into another is little different from the age-old practice of selecting for desirable traits from among wild plants and from occasional, spontaneous hybrids or mutants. Norman Borlaug, whose work with wheat did not include transgenic strains, makes just this point, in a paper reprinted from the journal, *Plant Physiology*. Putting genes from other species into domestic corn may well create unusual proteins that some people will be allergic to; but far more common are allergies to peanuts and chocolate, and that problem is handled in grocery stores by careful labelling.

The demonstrator in the street is not represented in this volume, but some of his concerns (expressed in solemn prose) are. It may be that genetically modifed organisms will provoke an environmental catastrophe some day. But it is beyond argument that our agriculture is already an environmental catastrophe. It is hard to see how the transgenic future could be any worse.

Modern biotechnology is maligned as "playing God," "altering the natural order of things." (That's what so appalled young Victor Frankenstein.) But the natural order of things certainly includes dying of smallpox, diphtheria, tetanus, and so on. If we eliminate the smallpox virus from nature, or introduce vaccines against pertussis and a host of other diseases, we are emphatically altering the natural order of things, and yet we bestow our grandest honors upon people like Jonas Salk and Albert Sabin who saved us from contracting poliomyelitis. And we gave a Nobel Peace Prize to Norman Borlaug for his efforts to feed the world's burgeoning billions.

The ethical argument that underlies so much of the controversy is explained most lucidly by Jeffrey Burkhardt, pp. 63–82. It's a liberal education to read this chapter. However: "Golden Rice" has been created with one daffodil gene and two bacterial genes that together code for an increased level of provitamin A, thereby potentially reducing all manner of human suffering. It seems unlikely that someone electing to feed this to his children is going to wrestle with ethical paradigms, no matter how elegantly presented by Professor Burkhardt. With respect, I submit that ethics is the province of the wealthy and the pampered.

There is a huge and growing literature on the subject of genetic modification of crops and biotechnology. The best place I have seen to get started on the subject is this volume. As is typical of such volumes, alas, it has no index. You'll want to know that the Monsanto fiasco with the "Terminator Gene" in seeds is covered on pp. 19–20; otherwise, you'll have a devil of a time finding it later.

—Neil A. Harriman
Biology Department
University of Wisconsin-Oshkosh
Oshkosh, Wisconsin 54901
harriman@uwosh.edu

THE BIG TREES OF MICHIGAN
27. Prunus pensylvanica L.f.
Pin Cherry

Kenneth M. Hiser & Elwood B. Ehrle

Department of Biological Sciences
Western Michigan University
Kalamazoo, MI 49008

The largest known Pin Cherry in Michigan is located in Fischer's Woods, 2.5 miles north of the city of Kalamazoo (Kalamazoo County) in the southwestern portion of the Lower Peninsula.

Description of the Species: The Pin Cherry is a member of the rose family, Rosaceae, and is characterized by having showy, insect-pollinated, perfect flowers. Within this family, five tree genera are native to Michigan. The genus *Prunus*, with seven species native to Michigan, is distinguished by having drupes ("stone" fruits) and often paired glands at the base of the leaf blade (Voss 1985).

The drupes of the Pin Cherry are bright red and borne in umbels. The leaves are alternate with oblong-lanceolate blades having finely serrate margins (with incurved teeth), tapering to a sharp tip (see Fig. 1). The bark of its twigs is light reddish-brown, thin, smooth (often peeling), with prominent, widely-spaced orange lenticels. Flowers generally appear in late spring, and are distinctly perigynous, with five white petals. The Pin Cherry is characteristically a fast-growing, short-lived "nurse tree" found in open, upland areas. It is usually associated with *Populus* species and pines and gives way to other hardwoods.

Location of Michigan's Big Tree: The tree can be located by taking Kalamazoo Avenue west from downtown Kalamazoo to its end at Douglas Avenue. Take Douglas Avenue north 2.5 miles to the Hi-Lo Bar on the right side of the road. Just beyond the Hi-Lo is a paved private drive on the left side of the road. If you have obtained permission, follow the drive to the Fischer residence. There is a trail from the house through the woods past the tennis court. Near the top of a rise, the tree can be seen about twenty feet into the woods off the right side of the trail.

Description of Michigan's Big Tree: The tree is healthy, with a solid single trunk, measured at 48″ (122 cm) in circumference four and a half feet above the ground [Diameter=15″ (38 cm)]. Its crown spread was measured at 22′ (6.75 m), which is relatively small, probably due to the competition of many nearby trees. The tree is 95′ (29 m) tall.

INVITATION TO PARTICIPATE

If you would like to join us in extending this series of articles by visiting and describing one or more of Michigan's Big Trees, please contact Elwood B. Ehrle for help with locations, specifications for taking measurements, and assistance

FIGURE 1. Documented distribution in Michigan and characteristics of the Pin Cherry. Map is from Voss (1985). Illustrations are from Barnes & Wagner (1991). 1. Winter twig ×1; 2. Portion of twig, enlarged; 3. Leaf ×¾. 4. Margin of leaf, enlarged; 5. Flowering twig, ×½; 6. Flower, enlarged; 7. Fruit, drupes, ×1.

with the manuscript. The Michigan Botanical Club encourages your involvement in this activity. Please remember to ask permission before entering private property.

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THE BIG TREES OF MICHIGAN
28. Salix matsudana Koidzumi f. tortuosa Rehder
Corkscrew Willow

Kenneth M. Hiser & Elwood B. Ehrle
Department of Biological Sciences
Western Michigan University
Kalamazoo, MI 49008

The largest known Corkscrew Willow in Michigan is located in the city of Northport in Leelenau County in the northwest portion of the lower peninsula.

Description of the species: The Corkscrew Willow is a member of the Willow family, Salicaceae. This family is characterized by having flowers in catkins in early spring on dioecious plants, leaves which are simple and alternate, and seeds having a tuft of silky hairs. Within the family, the genus *Salix* is differentiated from the genus *Populus* by its single bud-scale (species of *Populus* have several overlapping scales), and the typically more narrowly lanceolate to ovate leaf blades of *Salix* (versus the broader ovate to deltoid leaf blades of *Populus*). Flowers of *Salix* are greatly reduced, consisting only of either stamens (2-10) or a single compound ovary (Barnes & Wagner 1991). Barnes and Wagner (1991) describe the willows as being particularly difficult to identify because of similarity in characteristics, great variation within species according to different environments, and frequent hybridization.

The Corkscrew Willow is native to China, Manchuria, and Korea. In North America, it is found only in cultivation, as an ornamental landscape plant. It is distinguished from several other *S. matsudana* formae and varieties, all of which should probably be treated as 'cultivars' (which are also widely cultivated in landscapes) by its spirally twisted and complexly interwoven branches and branchlets, which are upright or sometimes spreading (Rehder 1940). The leaves are lanceolate, glabrous, olive green on the upper surface and silver gray beneath. Like the branches, the leaves are often conspicuously twisted and contorted (Lanzara and Pizzetti 1978) (see Fig. 1).

Location of Michigan's Big Tree: Our largest Corkscrew Willow is located at 202 Waukazoo Street in Northport. If you enter Northport on M-22 from the south, the first stoplight is Main Street. Turn right onto Main Street and proceed about 75 yards to Waukazoo Street. The tree can be found in the back yard of the first house on the right side of Waukazoo Street.

Description of Michigan's Big Tree: The trunk of the tree splits into two trunks about 2 feet from the ground. The girth at the base of the main trunk is 88″(2.24 m). Of the two dividing trunks, the circumference at four and a half feet above the ground of the larger was measured at 66″ (168 cm) [Diameter=21″(53 cm)]. Each trunk has a major branch, one at 1½ feet (46 cm) and the other at 3' 4″ (102 cm) above the branching point. The tree is 73′ (22.25 m) tall, and has a crown spread that was measured at 44′ (13.4 m).

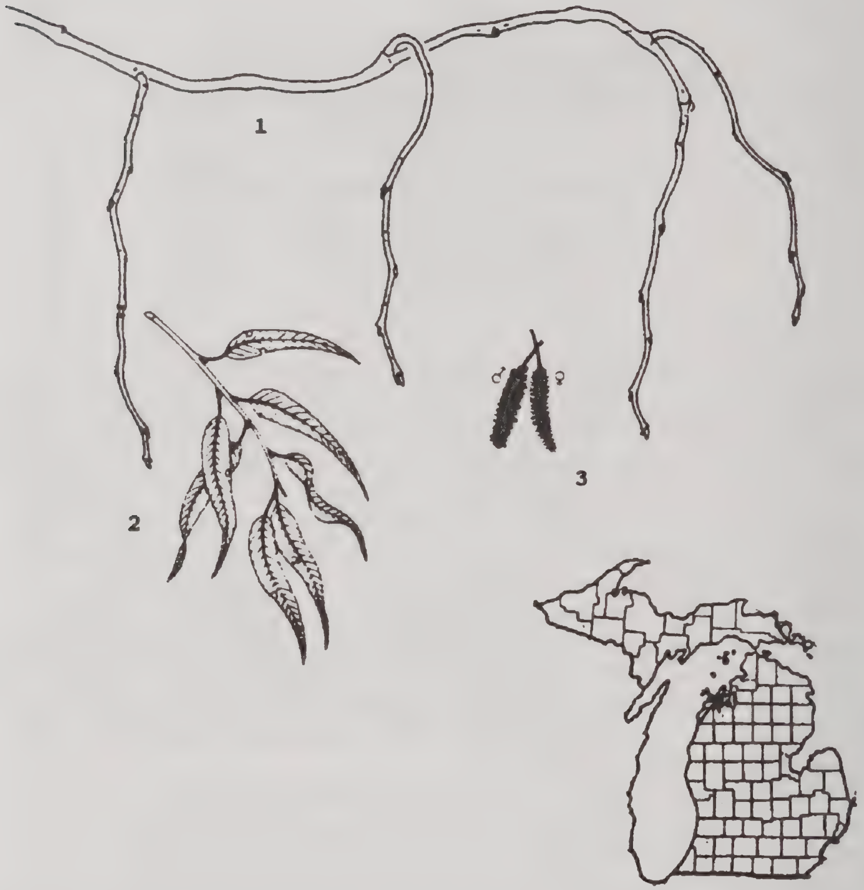

FIGURE 1. Characteristics of the Corkscrew Willow. The asterisk indicates the county where Michigan's Big Tree is located. Illustration no. 1 from Dirr (1983). 1. Winter twig ×¼. Illustrations 2 & 3 from Lanzara & Pizzetti (1978). 2. Twig with leaves ×¼. 3. Catkins ×½.

INVITATION TO PARTICIPATE

If you would like to join us in extending this series of articles by visiting and describing one or more of Michigan's Big Trees, please contact Elwood B. Ehrle for help with locations, specifications for taking measurements, and assistance with the manuscript. The Michigan Botanical Club encourages your involvement in this activity. Please remember to ask permission before entering private property.

LITERATURE CITED

Barnes, B.V., & W.H. Wagner, Jr. 1991. Michigan Trees. A Guide to the Trees of Michigan and the Great Lakes Region. University of Michigan Press, Ann Arbor. viii + 383 pp.

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BOOK REVIEW

Yatskievych, K. 2000. Field Guide to Indiana Wildflowers. Indiana University Press, Bloomington. Paperback; 358 pp. ISBN 0-253-21420-3 $17.95

Most amateur botanists are accustomed to the various field guides available for learning plant names for a particular state or region. Many of these guides have the plant species arranged in an artificial way by flower color and/or shape of the corolla and a color photograph of that species.

The bright red paper cover of this field guide is an indication that this book is different from all the rest covering the Great Lakes region. Most field guides are usually purposely incomplete in the species covered. 40% or more of the wildflowers of Indiana are not observed in available field guides. This book discusses all 1,564 herbaceous species known for the state (excluding grasses, rushes, and sedges). There are 640 color photographs with at least one photo image for each visually similar group or genus. The discussion of each species includes Latin name with author names, family, common name, and general description of the species, soils and ecology, habitat, distribution within Indiana, blooming time, plant size, the flowers and the inflorescence. Because Indiana is a state where four or five different written floras overlap in their coverage, and different Latin names may have been used, the author has placed these names in brackets for cross reference. There is also a brief discussion about the similarity and differences betweeen species. Species are noted as being native, introduced into the state, and those that are Endangered, Threatened, or Rare, Extirpated, or on a Watch List within the state. Some species have line drawings showing features that help in proper identification.

The species within the book are grouped by families with the families following a modified classification system similar to one proposed some years ago by Arthur Cronquist. The book begins with (1) *Saururus cernuus*, in the Saururaceae and ends with (1564) *Isotria verticillata* in the Orchidaceae. To get all the species listed with discussion in a book of only 358 pages, four to six species are grouped to a page.

To identify the species, the user must follow a Flower Finder. This finder is divided into eight parts where the unknown is compared to illustrations within each group. For example, Group A is corolla 2-lipped. The unknown flower is

compared with ten different sketches of 2-lipped corollas, then going to that part of the species listing of the guide and comparing those species which are most similar to it. One hopes that, with practice, the individual will be successful. Because 60% of the wildflowers listed lack sketches or photo images, this will take considerable practice on the user's part. Another difficulty comes with some groups having a long list of exceptions. For example, Group D, Flowers with petaloids numbering 5 has a two-column, half-page list of other examples to consider. This I can see could be very discouraging to all but the most determined amateur botanist.

The photographs are small but of good quality and illustrate the necessary features to properly identify most species. It is too bad more images were not used as this may discourage some amateur botanists from using the book.

There is a seven page word Glossary that is fairly complete for the terms used in the book. A single page labeled sketches of the parts of a flower and a labeled composite head inflorescence follows the glossary. This seems a bit lacking to this reviewer as there can be some very complex heads other than those found in the Aster family and corymbs, cymes, and panicles that need interpreting. A 37 page Index is most helpful when looking up species when the user already knows the identity of the plant. Only the genus *Rosa* was observed to be lacking.

Will this book replace the use of the more easy to use color-coded, thumb-through, color picture field guide used today by many an amateur botanist? Yes, for those wanting a guide only for Indiana. No, for those unwilling to put forth the time to identify completely one of the various *Potentilla* (cinquefoil) species, for example. However, Yatskievych is to be commended for her attempt to bring the American public to a higher level of botanical knowledge and scholarship. Time will tell if she is successful.

—Dennis W. Woodland
Biology Department, Andrews University
Berrien Springs, Michigan 49104-0410 U.S.A.
e-mail: woody@andrews.edu
Telephone: 616.471.3240; FAX: 616.471.6911

POA BULBOSA L. SSP. *BULBOSA* (POACEAE) IN NORTH AMERICA

Allison W. Cusick
Museum of Biological Diversity
The Ohio State University
1315 Kinnear Rd
Columbus, OH 43212
awcusick@aol.com

and

Michael A. Vincent
W.S. Turrell Herbarium
Department of Botany
Miami University
Oxford, OH 45056
513-529-2755
vincenma@muohio.edu

The Eurasian *Poa bulbosa* L. (bulbous bluegrass, Poaceae) is unique among North American grasses in its combination of tufted culms with bulbous bases and florets proliferating into bulbils (subspecies *vivipara* (Koeler) Arcangeli). *Poa bulbosa* grows in a variety of open, anthropogenic habitats, such as weedy fields, freshly-disturbed earth, campgrounds, and roadsides. This species is especially common in the western United States, but is widespread in the northeastern U.S. as well. The first published report of bulbous bluegrass in North America was by Piper (1924), from Virginia and Washington state. The species was being grown by the USDA as early as 1907 (both subspecies *bulbosa* and subspecies *vivipara*), and was known as a weedy species as early as 1915 (Schoth & Halperin 1932; Vinall & Westover 1928). Bulbous bluegrass is sometimes cultivated as a turf grass (Diesburg *et al.* 1997; Mangess *et al.* 1971), though it may go dormant in hot, dry periods (Ofir & Kerem 1982; Ofir 1986; Ofir & Kigel 1999). Oldham *et al.* (1995) provide a summary of the North American distribution of *P. bulbosa* ssp. *vivipara*. Novak & Welfley (1997) examined the genetic diversity of *Poa bulbosa* populations in the northwestern United States, and concluded that the high rate of diverse genotypes may be due to multiple introductions of the species, or due to sexual reproduction. Kartesz & Meacham (1999) map bulbous bluegrass as occurring in 43 of the lower 48 states in the United States, and in 3 Canadian provinces.

The nomenclaturally typical subspecies of *Poa bulbosa* has perfect flowers, rather than having the florets proliferating into bulbils. This typical variant has apparently been reported outside cultivation from North America only by one author (Halperin 1931), who reported subspecies *bulbosa* from California. It does not appear that the presence of subspecies *bulbosa* has been recognized as occurring in North America by any subsequent author. In the grass treatments by Weishaupt in Braun (1967) and by Weishaupt (1985), it is clear from the context that the scant references to *Poa bulbosa* in Ohio were entirely to *Poa bulbosa* subspecies *vivipara*, even though the subspecific nomenclature was not used in either work.

We have discovered that *Poa bulbosa* ssp. *bulbosa* not only grows in Indiana and Ohio, but is quite common in a specific habitat in those states. We were collecting at the Butler County fairgrounds in the city of Hamilton, Ohio, 29 April

FIGURE 1. Distribution of *Poa bulbosa* L. in Indiana and Ohio. Solid dots represent ssp. *bulbosa*. Open circles represent ssp. *vivipara* (distribution in the four northwestern Indiana counties follows Swink & Wilhelm [1994]).

1998, when we noted numerous clumps of a *Poa* with bulbous bases and perfect flowers. Later that same day, we found the same plant at the Darke County fairgrounds in Greenville, Ohio. Our collections were determined as *Poa bulbosa* ssp. *bulbosa* by Dr. Robert Soreng at the Smithsonian Institution.

We broadened our survey to other counties of Indiana and Ohio. Eventually, we had found the typical subspecies in four Indiana and 13 Ohio counties. All these collections were made in agricultural fairgrounds, most often at the racetracks on those sites. A search of fairgrounds in adjacent counties of Kentucky, Michigan, Pennsylvania and West Virginia located no populations of the subspecies *bulbosa*. Many of the Indiana and Ohio populations are quite vigorous with thousands of clumps over broad stretches of land.

We also searched for *Poa bulbosa* ssp. *vivipara*. We turned up numerous new county records of this subspecies in Indiana and Ohio. However, at no place did the two subspecies grow together or occur adjacent to one another. Also, we never found subspecies *vivipara* on a fairground. The subspecies *bulbosa* was restricted to that habitat. The results of our survey are presented in Figure 1. See Appendix A for a list of representative specimens of *Poa bulbosa* ssp. *bulbosa* from Indiana and Ohio.

Poa bulbosa ssp. *vivipara* obviously is more widespread in Indiana and Ohio than the typical subspecies. It, of course, grows in many more types of habitats than ssp. *bulbosa*. It also has been noted in the floras of those states for a longer time than the typical subspecies. The first Ohio collection of ssp. *vivipara* dates from 1963 (specimen at OS). The first Indiana reports of this subspecies are post-1991 (Swink & Wilhelm 1994).

Perfect flowering *vs.* proliferation of bulbils in *Poa bulbosa* has been linked to environmental factors. Kennedy (1929) describes proliferation in this species, as did Halperin (1933), who also discussed the nomenclature of the proliferous form. Younger (1960) induced proliferation of bulbils in this species by increasing air temperature and day length. This result, however, may not be typical for the strains of *Poa bulbosa* found in North America. Younger did not identify which subspecies of *P. bulbosa* he used in his studies. His experiments were conducted entirely on strains of *P. bulbosa* from Afghanistan. Plants in the Indiana and Ohio populations of this species were exclusively perfect-flowered or viviparous. No change in this status was observed over the course of the season.

Two obvious questions need to be addressed. Where did these plants of *Poa bulbosa* ssp.*bulbosa* originate and how do they spread from site to site? The question of origin is more difficult to answer. It seems unlikely that plants of this subspecies were introduced into Indiana and Ohio directly from Eurasia. Dr. Soreng (pers. comm., 1998) offers the following suggestion: "It is the nature of subspecies, in my opinion, to occasionally reform out of the genetic mix of other subspecies. Thus, it may be that your populations have arisen from subsp. *vivipara* and not from introductions of Old World populations of sexually reproducing plants of *P. bulbosa* subsp. *bulbosa*." Certainly, the uniformity of the populations over an extensive area argues for a single source of introduction.

It is much easier to account for the means by which the plants of ssp. *bulbosa* spread from site to site. The key here is the common factor of racetracks. Seeds, if any are produced, and loose bulbous bases may easily travel in caked earth or mud on the hooves of horses or the wheels of vehicles. Many racecourses on county fairgrounds are used for tractor-pulling competitions. The tractors are an obvious vector as they travel from fairground to fairground. The distribution and spread of *Poa bulbosa* ssp. *bulbosa* parallels that of *Sclerochloa dura* (L.) P. Beauv. (Cusick et al. in prep.), another characteristic species of racetracks and fairgrounds.

Broader surveys of suitable habitats may reveal the true geographical extent of *Poa bulbosa* ssp. *bulbosa* in North America.

ACKNOWLEDGMENTS

We thank the curators at herbaria CM, IND, KE, MICH, MU, OS for access to specimens in those herbaria. Dr. Rob Soreng (US) provided the identification of our first collection of this taxon. Dr. Richard Rabeler (MICH) provided information valuable to our study.

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APPENDIX A: COLLECTIONS OF *POA BULBOSA* SSP. *BULBOSA* FROM INDIANA AND OHIO.

INDIANA: Fayette Co., Fayette Co. fairgrounds, Connersville, 28 Apr 1999, *M.A. Vincent 8470 & A.W. Cusick* (BRY, ILLS, MO, MU, OSH); Huntington Co., Hier's Park, Huntington, 9 May 2000, *A.W. Cusick 35388 & R.K. Rabeler* (MU); Jay Co., Jay Co. fairgrounds, Portland, 9 May 2000, *A.W. Cusick 35403 & R.K. Rabeler* (MU); Wabash Co., Wabash Co. fairgrounds, Wabash, 9 May 2000, *A.W. Cusick 35393 & R.K. Rabeler* (MU). **OHIO**: Butler Co., Butler Co. fairgrounds, Hamilton, 29 Apr 1998, *M.A. Vincent 8217 & A.W. Cusick* (BRY, MU, NBYC, US, WSU); Darke Co., Darke Co. fairgrounds, Greenville, 29 Apr 1998, *M.A. Vincent 8230 & A.W. Cusick* (MU); Fayette Co., Fayette Co. fairgrounds, 20 Apr 1999, *A.W. Cusick 34790* (MU, OS); Hamilton Co., Hamilton Co. fairgrounds, Wyoming, 30 Apr 1998, *A.W. Cusick 34283* (MU, OS); Highland Co., Highland Co. fairgrounds, Hillsboro, 20 Apr 1999, *A.W. Cusick 34799* (MU, OS); Lake Co., Lake Co. fairgrounds, Painesville, 2 May 2000, *A.W. Cusick 35350* (MU, OS); Logan Co., Logan Co. fairgrounds, Bellefontaine, 18 May 1998, *A.W. Cusick 34351* (MU, OS); Miami Co., Miami Co., fairgrounds, Troy, 14 May 1998, *A.W. Cusick 34316* (MU, OS), same location, 25 Apr 2000, *A.W. Cusick 35330* (MU, OS); Monroe Co., Monroe Co. fairgrounds, NE of Woodsfield, 6 May 1998, *A.W. Cusick 34295* (MU, OS); Montgomery Co., Montgomery Co. fairgrounds, 25 Apr 2000, *A.W. Cusick 35337* (MU, OS);

Preble Co., Preble Co. fairgrounds, 29 Apr 1998, *M.A. Vincent 8224 & A.W. Cusick* (ISC, MU, US); Shelby Co., Shelby Co. fairgrounds, Sidney, 25 Apr 2000, *A.W. Cusick 35324* (MU, OS); Union Co., Union Co. fairgrounds, N. of Marysville, 14 May 1998, *A.W. Cusick 34327* (MU, OS), same location, 4 May 1999, *A.W. Cusick 34872 & R.K. Rabeler* (MU, OS), "Past-time Park," N of Plain City, 4 May 1999, *A.W. Cusick 34874 & R.K. Rabeler* (MU, OS); Wyandot Co., Wyandot Co. fairgrounds, N of Upper Sandusky, 9 May 2000, *A.W. Cusick 35835* (MU, OS).

CONTENTS

On the cover: *Mature hart's tongue fern,* Asplenium scolopendrium, *growing in moss mat, with an unidentified violet at the right, on a dolomite boulder, Mackinac County, MI. Photo by Janice M. Glime, Michigan Technological University, Houghton, MI 49931, July, 1993.*

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DICRANUM BREVIFOLIUM NEW TO THE MOSS FLORA OF MICHIGAN AND THE EASTERN UNITED STATES

Robert R. Ireland

Smithsonian Institution, Botany
National Museum of Natural History
Washington, D.C., 20560-0166

While studying the moss genus *Dicranum* (Dicranaceae) for the Bryophyte Flora of North America project, I discovered a sterile specimen of *D. brevifolium* (Lindberg) Lindberg from Michigan in the herbarium of the Smithsonian Institution. It had been misidentified as *D. undulatum* Bridel, a related and more common species that occurs in bogs in both the Upper and Lower Peninsula of the state (Darlington 1964). The specimen of *D. brevifolium*, which is from Marquette Co. in the Upper Peninsula of Michigan, represents a species that is not only new to the state but is also the first record from the continental United States east of the Mississippi River (Bellolio-Trucco & Ireland 1990). It is an arctic-alpine species so its occurrence in the Upper Peninsula was not totally unexpected. G.E. Nichols (1935) first commented on the arctic-alpine bryophyte element in the vegetation of the Upper Peninsula, citing such species as *Polytrichastrum alpinum* (Hedwig) G.L. Smith (as *Polytrichum alpinum* Hedwig) and *Andreaea rupestris* Hedwig (as *A. petrophila* Ehrhart). Later, W.C. Steere (1937) also discussed the arctic-alpine bryophyte element in the flora of the Upper Peninsula.

The specimen data for the *D. brevifolium* record are as follows: Michigan, Marquette Co., 11 mi. ESE of Marquette, along Lake Superior on Michigan Route 28, *F.J. Hermann 28551*, 29 July 1978 (US). Det. as *Dicranum undulatum* Bridel. *Cladonia-Vaccinium* understory of sandy jack pine plain.

Besides occurring in Michigan's Upper Peninsula, the species has been found to occur mainly in western North America, with a number of scattered localities in the northeastern part of the continent as determined from my recent field collections and some confirmed herbarium specimens by other collectors. It occurs elsewhere in North America on humus or soil over rock, rarely rotted wood, exposed or shaded bluffs or cliffs, 70–3700 m. The distribution of *D. brevifolium* (Fig. 1) is still very sketchy and incompletely known because of its confusion with several other species discussed in this paper. Thus far, it is known to occur in the following localities (specimens have been examined in a number of North American herbaria but only representative specimens verified in the herbaria of the Canadian Museum of Nature (CANM) or the Smithsonian Institution (US) are cited here): Greenland (CANM), Canada (Alberta (US), British Columbia (CANM, US), Manitoba (CANM), Newfoundland (CANM), Northwest Territories (CANM), Nunavut (CANM), Ontario (CANM), Quebec (CANM), Yukon Territory (CANM)) and the United States (Alaska (US), Colorado (CANM),

FIGURE 1. Known distribution of *Dicranum brevifolium* in North America and Greenland from verified herbarium specimens. The black circles represent specific localities, the stippled areas in the western USA and Canada represent generalized distribution.

Montana (US), New Mexico (CANM), South Dakota (CAMN)). Outside of North America it is known from Europe and Asia (Nyholm 1986).

Dicranum brevifolium is in the family Dicranaceae, section *Spuria* Bruch, Schimper & W. Gümbel, as defined by Nyholm (1986). Members of this section have male plants dwarfed, on rhizoids of female plants or as large as females; leaves with 1- to 2-stratose, rarely 3-stratose alar regions; costa excurrent or subpercurrent, smooth or rough on abaxial surface in distal part of leaf; leaf cells ± isodiametric, usually papillose and nonpitted above, elongate below, with or without pits, smooth peristome teeth pitted-striolate below, papillose above. Other North American species in the section are *D. acutifolium* (Lindberg & Arnell) C.E.O. Jensen in A.H. Weimarck, *D. condensatum* Hedwig, *D. ontariense* W.L. Peterson, *D. spurium* Hedwig, and *D. undulatum* Bridel. All but *D. acutifolium*, another arctic-alpine species like *D. brevifolium*, also occur in Michigan.

Dicranum brevifolium is distinguished by the leaves, 4–8 mm long, acute,

often weakly undulate in the distal part, crisped when dry, standing out from the stems often at wide angles, concave below, keeled above; laminae often with some bistratose regions above, commonly on margins and near costa, sometimes entirely bistratose with tristratose margins (especially on plants at high altitudes in Alberta); costa percurrent or shortly excurrent, very prominent and conspicuously rounded, usually noticeable below the leaf middle; cross section of leaves very distinctive, shaped like a pair of tongs (i.e., like outside calipers with the tips bent inward), abaxial epidermal layer of costal cells differentiated but no adaxial epidermal layer cells enlarged, and cell walls between lamina cells nearly always strongly bulging. Illustrations of the species, as well as the other *Dicranum* species mentioned in this paper, may be found in Bellolio-Trucco & Ireland (1990) and Nyholm (1954, 1956).

Dicranum brevifolium was originally described as a variety of *D. muehlenbeckii* Bruch, Schimper & W. Gümbel by S.O. Lindberg in the 1860's but he later raised it to a species in the 1870's. Since then others have usually recognized it either as a species (Nyholm 1986; Williams 1913) or as a variety (Nyholm 1954; Podpěra 1954).

The species is best known by its gametophytic characters. It is easily distinguished from *D. muehlenbeckii*, which has tubulose leaves in the distal half, rather than keeled leaves, and costae that are much less prominent on the abaxial surface than those of *D. brevifolium*. In cross section of the distal half of the leaves, *D. muehlenbeckii* has unistratose laminae, a tubular outline, cell walls between the lamina cells that are smooth and an adaxial epidermal layer of costal cells that are differentiated. This is in contrast to *D. brevifolium* whose leaves have a tong-shaped outline, cell walls between the lamina cells strongly bulging and an adaxial epidermal layer of costal cells undifferentiated.

Other species that can be confused with *D. brevifolium* are *D. acutifolium*, *D. fuscescens* Turner and some forms of *D. undulatum*.

Dicranum brevifolium is probably the most difficult to distinguish from *D. acutifolium*. The latter differs by its erect-spreading to slightly curled leaves when dry, its costae that are usually moderately distinct and sometimes nearly flat on the abaxial surface and its V-shaped leaves in cross section. In comparison, the former has crisped leaves standing out from the stems at wide angles, costae that are prominent and conspicuously rounded on the abaxial surface, and tong-shaped leaves in cross section. Sporophytically, *D. acutifolium* has shorter capsules, 2.0–2.5 mm, compared to the longer capsules, 3–4 mm, of *D. brevifolium*.

Dicranum fuscescens differs from *D. brevifolium* by its much less prominent costae on the abaxial leaf surface, by its V-shaped leaves in cross section, instead of tong-shaped leaves, by its laminae that are only bistratose on the margins, instead of having bi- to tristratose regions on the margins and scattered throughout, and by its weakly bulging or nearly smooth cell walls, rather than strongly bulging ones, as seen in cross section.

Dicranum undulatum can easily be differentiated from *D. brevifolium* by its broadly acute leaf apices and costae that are subpercurrent, compared to the narrowly acute leaf apices and percurrent to shortly excurrent costae that are characteristic of the latter species. Occasionally, there are forms of *D. undulatum*

with narrowly acute leaf apices that can be confused with *D. brevifolium* but the broadly recurved leaves in the distal half of the leaves of the former will easily distinguish the species from the latter species that has incurved leaves.

Dicranum brevifolium probably occurs elsewhere in Michigan's Upper Peninsula and in many other arctic-alpine localities throughout North America. It should be found on humus or soil over rock, rotting wood, and exposed or shaded bluffs and cliffs.

ACKNOWLEDGMENTS

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BRYOPHYTES OF THE PICTURED ROCKS NATIONAL LAKESHORE, ALGER COUNTY, MICHIGAN, USA

Janice M. Glime
Department of Biological SciencesMichigan
Technological University
Houghton, MI 49931
jmglime@mtu.edu

ABSTRACT

Field sampling for the present study includes relevés of shoreline, coniferous forest, hardwood forest, mixed hardwood/coniferous forest, wetlands, and disturbed areas within the Pictured Rocks National Shoreline. This study adds 90 taxa of mosses, bringing the published total to 138 taxa (species and varieties) of mosses, and 18 liverworts, bringing that total to 38. The representative bryophytes in different habitats are discussed.

Buxbaumia aphylla was found in the park for the first time, although it is relatively common in the Upper Peninsula of Michigan. Nine other uncommon and rare taxa were added to the list of known species in the park: *Anomodon minor, Calypogeja fissa* (liverwort), *Didymodon rigidulus, Herzogiella striatella, Hylocomium umbratum, Polytrichum pallidisetum, Rhabdoweisia crispata, Sphagnum wulfianum,* and *Tortula mucronifolia.*

INTRODUCTION

The Pictured Rocks National Lakeshore occupies a location encompassing a variety of habitats, many of which are rare in Michigan. The Lakeshore lies in Alger County on the southern shore of Lake Superior, and therefore it occupies a significant portion of the undeveloped U.S. shoreline. Because of the effects of the lake, the northern position of the park in the Midwestern part of the country, and the alkaline sandstones, the park offers unique opportunities for finding plants that may occur nowhere else in the U.S., or at least nowhere else in the Midwest. Therefore, the preservation of selected habitats within the park, where such unusual flora and fauna can be expected, is important to meet part of the mission of the National Parks.

Two French explorers, Radisson and Groseilliers, in the early 1660s, were probably the first Europeans to explore the Pictured Rocks area (Thwaites 1888). The first botanical description is attributed to Doty, based on his participation in the 1820 Cass Expedition (Doty 1895). But he stated only that "birch, beech and maple" grow along the top of the cliff. Subsequently, a number of botanical observations and collections of vascular plants have been reported (Dodge 1918; Fernald 1935; Cain 1962; Frederick, *et al.* 1977; Bach 1978; Crispin, et al. 1984). Read (1975) studied the vascular plants of Pictured Rocks, described the major vegetation types, and gave a detailed species checklist.

Although there have been considerable investigations of vascular plant flora in the national parks nationwide, their bryophytes are still little known, particu-

larly in Midwestern national parks, being studied primarily in the western parks (Standley 1920; Porter 1932; Haring 1941, 1946; Persson & Weber 1958; Hong 1968, 1980; Hermann 1969, 1973, 1987; Magill 1976; Hoe 1979; Seyer 1979; Smith 1981; Showers 1982; Spence 1985; Blaney & Norris 1987). Few studies of bryophytes have addressed any park in the eastern half of the United States (e.g. Prior 1959; Ireland 1961). Only Isle Royale has been studied in any detail (Cooper 1912, 1913; Conklin 1914; Thorpe & Povah 1935; Hermann 1962; Rutkowski 1984; Meston 1985).

In temperate and boreal regions bryophytes can play a very important ecological role in the forest ecosystem (Slack 1977, 1983; Glime 2001). Bryophyte communities are generally delimited by vascular plant communities, although bryophytes can have broader niches and form fewer communities within a habitat gradient than do vascular plants (Glime et al. 1982). The succession of the forest and the degradation of the environment will substantially influence the composition of the bryophyte flora in many different ways. Establishment of national parks provides the opportunity of not only protecting the natural habitat and forest but also conserving the bryophyte flora associated with the natural forest.

Several bryologists have found particularly interesting bryophytes at Pictured Rocks National Lakeshore (Steere 1934; Conard 1938; Schuster 1949), but no comprehensive list of the taxa has ever been published. The interesting bryophytes already known from nearby areas, such as the rare *Tetradontium brownianum, Cirriphyllum piliferum,* and *Timmia megapolitana* at Tannery Falls in Alger County (Bowers 1987), likewise suggest that the park should harbor interesting species. The purpose of this survey was to assess the bryophyte vegetation from representative habitats to locate any interesting, endangered, or rare species, and to provide a checklist of the bryophytes known from the park.

DESCRIPTION OF STUDY AREA

The Pictured Rocks National Lakeshore occupies 71,397 acres of land along the southern shore of Lake Superior in the north-central section of the Upper Peninsula of Michigan, 46°N latitude, 86°W longitude. The most spectacular feature of the lakeshore is a 20 km shoreline of multicolored sandstone cliffs rising, at places, almost 60 m above the lake. Its sand dunes, reaching 90 m, are unique in the Upper Peninsula and provide unusual ridge and valley habitats supporting a variety of plant communities.

Read (1975) described how the vegetation along the Lake Superior shoreline, the most attractive feature of the National Lakeshore, is strongly influenced by the moderating effects of the lake. The actual lake frontage may be divided into two types: beach strand-dune community and the sandstone cliff community. The beach strand-dune community is well developed on Sand Point, Miners Beach, Chapel Beach, and Twelve Mile Beach, the latter bordering our sampling corridor.

We concentrated our sampling in a forested corridor 0.7 km wide and 10 km long, which borders the shoreline (Fig. 1), on 25–28 May 1991. The corridor in-

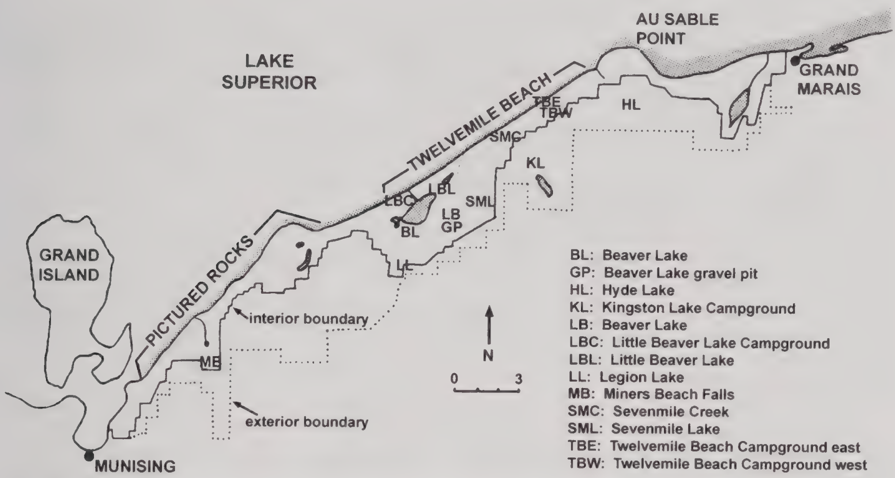

FIGURE 1. Map of Pictured Rocks National Lakeshore, Alger County, Michigan, showing locations of collection areas. For detailed locations, see Table 1. (Redrawn from Read 1975.)

cludes coniferous forest, northern hardwood, hardwood with small coniferous component, hardwood with significant coniferous component, and pine barrens (NPS Assessment of Alternatives for Pictured Rocks National Lakeshore 1980). Although a variety of habitats exists in the park, the corridor is limited to forested areas, with only a few small woodland fen pools surrounded by *Sphagnum*, a gravel pit, and open trails and parking lots offering habitat variability. In addition to the corridor, collections were made at the cliff community of Miners Beach, since that community is the one most likely to include interesting and rare taxa, and earlier (1982) at Little Beaver Lake and Little Beaver Lake Campground. Additional records are from the literature.

METHODS AND PROCEDURES

Seven members of the Michigan Technological University Bryology Lab sampled by relevés in the major habitats of the corridor and other areas, with more intense examination at Miners Beach. During the investigation, each taxon identifiable as potentially different in each vegetation type and habitat was collected and labelled. There were 1,500 specimens collected. Literature citations of species previously found in the park are indicated as such in Table 1.

Scientific names of mosses follow the latest List of Mosses of North America North of Mexico provided by Anderson et al. (1990); the names for liverworts follow Stotler & Crandall-Stotler (1977) and Crum (1991). Nomenclature for vascular plants follows Gleason & Cronquist (1991). Voucher specimens of all bryophytes are in the Michigan Technological University Cryptogamic Herbarium (MCTC).

RESULTS AND DISCUSSION

To the list of known taxa, we have added 90 moss taxa and 18 liverwort taxa, bringing the totals to 136 and 38, respectively (Table 1). These numbers compare

TABLE 1. Bryophyte species checklist of Pictured Rocks National Lakeshore. Species known from the literature are listed with reference in parentheses; nomenclature has been changed to conform with Anderson *et al.* 1990. Collections examined in this and the 1982 study have the following codes to denote collecting sites:

BL: about 2 km southeast of Beaver Lake, west of the parking area about 1.5 km (46° 33′ N, 86° 19′ W, T48N R16W, Sec. 21)

GP: road from H58 to the parking area about 3 km southeast of Beaver Lake, gravel pit north of road (46° 32′ N, 86° 19′ W, T48N R16W, Sec. 21)

HL: about 1/2 km southeast of Hyde Lake (46° 34′ N, 86° 16′ W, T48N R16W, Sec. 14)

KL: trail from Twelvemile Beach to Kingston Lake Campground (46° 37′ N, 86° 15′ W, T49N R15W, Secs. 24,25)

LB: about 3 km southeast of Beaver Lake; parking area and along trail to Little Beaver Campground (46° 33′ N, 86° 18′ W, T48N R16W, Secs. 15, 16)

LBC: Little Beaver Lake Campground, 1982 collections of Janice M. Glime (46° 30′ N, 86° 30′ W, T48N R17W, Sec. 18)

LBL: Near Little Beaver Lake, 1982 collections of Janice M. Glime (47° 30′ N, 86° 30′ W, R48N R17W)

LL: about 1/2 km E of Legion Lake, westernmost end of corridor (46° 32′ N, 86° 21′ W, T48N R16W, Sec. 30)

MB: Miners Beach Falls (46° 30′ N, 86° 32′ W, T47N R18W, Secs. 2, 3)

SMC: about 1 km south of the mouth of Sevenmile Creek, near NPS boundary markers on trees (46° 37′ N, 86° 15′ W, T49N R16W, Sec. 25)

SML: about 1 km north northeast of Sevenmile Lake (46° 35′ N, 86° 17′ W, T48N R16W, Sec. 2)

TBE: near the road between Twelvemile Beach Campground and the parking area ca 1 km to east (46° 38′ N, 86° 13′ W, T49N R15W, Sec 17)

TBW: road about 1 km south of the parking area just east of Twelvemile Beach Campground, west side of the road (46° 38′ N, 86° 13′ W, T49N R15W, Secs. 17, 20)

MOSSES

Amblystegium varium (Hedw.) Lindb. (Miners Castle, Richards 1952)

Anomobryum filiforme (Dicks.) Solms in Rabenh. (Conard 1938)

Anomodon attenuatus (Hedw.) Hüb. [JG13210] BL, KL, LB, LBL

Anomodon minor (Hedw.) Fürnr. [NL1585] BL, SMC

Atrichum altecristatum (Ren. & Card.) Smyth & Smyth [JG13318] BL, HL, LB, SMC, SML

Atrichum angustatum (Brid.) Bruch & Schimp. in B.S.G. GP, HL, KL, LBL, LL

Aulacomnium palustre (Hedw.) Schwaegr. [JG13386a] KL

Barbula convoluta var. *convoluta* Hedw. [JZ1172] MB, SML, TBE

Barbula unguiculata Hedw. [JZ1068] BL, GP, TBE

Bartramia pomiformis Hedw. [JG5496] LBC

Brachythecium oxycladon (Brid.) Jaeg. [JZ1096] GP, HL, KL, LB, LL, SMC, SML, TBE

Brachythecium plumosum (Hedw.) Schimp. in B.S.G. [JZ1063] SMC, TBE

Brachythecium reflexum (Starke ex Web. & Mohr.) BSG (Grand Sable Dunes, Bowers 1987) [JG13216] BL, HL, LB, LBC, LBL, LL, MB, SML, TBE

Brachythecium rivulare Schimp. in B.S.G. [JZ1162B] LBC, MB, SML

Brachythecium salebrosum (Web. & Mohr) Schimp. in B.S.G. var. *salebrosum* (Grand Sable Dunes, Bach 1978) [JZ1195A] TBE, MB, SML, BL, KL, LB

Brachythecium velutinum (Hedw.) Schimp. in B.S.G. var. velutinum [JZ1110C] KL, LB, SMC, SML

Brotherella recurvans (Michx.) Fleisch. [JZ1077] HL, KL, LBC, LBL, SMC, SML, TBE

Bryhnia novae-angliae (Sull. & Lesq. in Sull.) Grout (Grand Sable Dunes, Bowers 1987) [NL1528] MB

Bryoerythrophyllum recurvirostre (Hedw.) Chen [JZ1171] MB

Bryum argenteum Hedw. [JG13201] BL, LB, MB

Bryum caespiticium Hedw. (Miners Castle, Richards 1952) [JG13432] MB

Bryum capillare Hedw. [JZ1195C] SML

Bryum lisae var. *cuspidatum* (Bruch & Schimp. in B.S.G.) Marg. [JZ1002] LB, MB

Bryum pallens (Brid.) Sw. in Röhl. (rock crevices along shore, Nichols 1933)

Bryum pseudotriquetrum (Hedw.) Gaertn. et al. [NP224] GP, LBL, MB, SML

TABLE 1. (Continued)

Buxbaumia aphylla Hedw. [NP197] KL, SMC
Callicladium haldanianum (Grev.) Crum [JG13317] BL, GP, HL, KL, LB, LBL, SMC, SML, TBE, TBW
Campylium hispidulum (Brid.) Mitt. [NP2] LB, SMC
Campylium polygamum (Schimp. in B.S.G.) C. Jens. [NP19] LB
Catoscopium nigritum (Lake Superior shore, Nichols 1933; Conard 1938)
Ceratodon purpureus (Hedw.) Brid. [JG13269] BL, GP, HL, KL, LB, MB, SML, SMC, TBE
Climacium dendroides (Hedw.) Web. & Mohr [NP223] LBC, MB
Cratoneuron filicinum (Hedw.) Spruce [JZ1167A] MB
Desmatodon obtusifolius (Schwaegr.) Schimp. (sandstone cliffs, Steere 1934; Conard 1938; Miners Castle, Richards 1952) [JZ1178] MB
Dichodontium pellucidum (Hedw.) Schimp. (base of lake bluffs, Nichols 1933; Conard 1938) [JZ1167B] KL, MB
Dicranella cerviculata (Hedw.) Schimp. (moist sandstone, ledge of cliff, Miners Castle, Crum & Miller 1968)
Dicranella grevilleana (Brid.) Schimp. (moist gravelly slopes at Miners Falls, Nichols 1933)
Dicranella heteromalla (Hedw.) Schimp. (Grand Sable Dunes, Bach 1978) [JZ1220] BL, HL, LB, LBC, LL, SMC
Dicranum flagellare Hedw. [JG13281] KL, SML, TBE, TBW
Dicranum fuscescens Turn. [JZ1039B] HL, KL, SML, TBE, TBW
Dicranum montanum Hedw. [JZ1060] BL, GP, HL, KL, LB, LBL, LL, MB, SMC, SML, TBE, TBW
Dicranum polysetum Sw. (Grand Sable Dunes, Bowers 1987) [JG13407] GP, KL, LBC, TBE, TBW
Dicranum scoparium Hedw. (Nichols 1933) [JZ1037] BL, GP, HL, KL, LB, SMC, SML, TBE, TBW
Dicranum undulatum Brid. [JG13414] KL
Dicranum viride (Sull. & Lesq. in Sull.) Lindb. [JZ1027] BL, HL, KL, LB, SMC, SML, TBE
Didymodon rigidulus var. *rigidulus* Hedw. [JG13446] MB
Diphyscium foliosum (Hedw.) Mohr [NP33] LB
Ditrichum flexicaule (Schwaegr.) Hampe (Grand Sable Dunes, Bach 1978)
Encalypta ciliata Hedw. (Miners Falls, Steere 1934) [NL1718] MB
Eurhynchium pulchellum (Hedw.) Jenn. [JM1162] LBC, TBE
Fissidens dubius P. Beauv. [NP51B] BL
Fissidens osmundioides Hedw. LBL
Fontinalis hypnoides var. *duriaei* (Schimp.) Husn. [JG5536] LBL
Funaria hygrometrica Hedw. [JG13420] MB
Gymnostomum aeruginosum Sm. [JZ1170B] MB
Herzogiella striatella (Brid.) Iwats. [JG13255] TBE
Hygroamblystegium fluviatile (Hedw.) Loeske [JG13434] MB
Hygroamblystegium noterophilum (Sull. & Lesq. in Sull.) Warnst. (Miners Falls, Steere 1934)
Hygroamblystegium tenax (Hedw.) Jenn. (Miners Falls, Nichols 1935) [JG13423] KL, LB, MB
Hygrohypnum luridum (Hedw.) Jenn. (along lakeshore & Miners Falls, Nichols 1933) [JZ1175] MB, SML
Hylocomium splendens (Hedw.) Schimp. in B.S.G. [NL1668] KL, LBL, TBE
Hylocomium umbratum (Hedw.) Fleisch. in Broth. [JG5533] LBL
Hymenostylium recurvirostre (Hedw.) Dix. (Miners Castle, Nichols 1933; Richards 1952) [JZ1174A] KL, MB, TBE
Hypnum cupressiforme L. (lake shore, Nichols 1933)
Hypnum imponens Hedw. [JG13379] KL, SMC, TBE
Hypnum pallescens (Hedw.) P. Beauv. var. *pallescens* [JG13330] BL, GP, KL, LB, LBL, SMC, SML, TBE, TBW
Leptobryum pyriforme (Hedw.) Wils. [JZ1174C] MB, SMC
Leptodictyum humile (P. Beauv.) Ochyra [NL1562] LB
Leptodictyum riparium (Hedw.) Warnst. [JG5524] LBL
Leskeella nervosa (Brid.) Loeske [JG13215] BL, GP, HL, LB, TBE, SML
Leucobryum glaucum (Hedw.) Ångstr. in Fries [JG13285] KL, TBE
Leucodon brachypus var. *andrewsianus* Crum & Anderson (Miners Rock, Bowers 1987) [NL1556] BL, LB

(Continued)

TABLE 1. (Continued)

Meesia triquetra (Richt.) Ångstr. (rock crevices near lake shore, Nichols 1933)
Mielichhoferia mielichhoferiana (Funck in Hook.) Loeske var. *mielichhoferiana* (sandstone cliffs, Nichols 1933; Conard 1938; near Miners Castle, Crum & Miller 1968; Miners Rock, Crum & Anderson 1981)
Mnium spinulosum Bruch & Schimp. in B.S.G. [JZ1198] SMC, SML
Mnium thomsonii Schimp. [JZ1190] LL, SML
Myurella julacea (Schwaegr.) Schimp. in B.S.G. (Lake Superior shore, Nichols 1933; Miners Castle, Richards 1952)
Myurella sibirica (C. Müll.) Reim. (Miners Castle, Richards 1952)
Neckera pennata Hedw. [JZ1029A] BL, KL, SMC
Orthotrichum sordidum Sull. & Lesq. in Aust. [JZ1025B] BL, GP, KL, LBC, SMC, TBW
Orthotrichum speciosum var. *elegans* (Schwaegr. ex Hook. & Grev.) Warnst. (Miners Rock, Bowers 1987)
Paraleucobryum longifolium (Hedw.) Loeske [NP53A] BL
Philonotis fontana (Hedw.) Brid. var. *fontana* (Miners Castle, Richards 1952) [JG13457] MB
Plagiomnium ciliare (C. M.) T. Kop. [JG13223] BL, KL, LB, LBL, LL
Plagiomnium cuspidatum (Hedw.) T. Kop. [JZ1106B] BL, GP, LB, LL, MB, SMC, TBE, TBW
Plagiomnium ellipticum (Brid.) T. Kop. [JZ1008] LB
Plagiothecium cavifolium (Brid.) Iwats. [JG13317a] HL, LB, LL, SMC, SML, TBW
Plagiothecium laetum Schimp. in B.S.G. [NP176] BL, GP, HL, KL, LB, LL, MB, SML, TBE
?*Platydictya subtilis* (Hedw.) Crum [JZ1189A] SML
Platygyrium repens (Brid.) Schimp. in B.S.G. (Grand Sable Dunes, Bowers 1987) [JZ1188] BL, HL, LB, MB, SMC, SML, TBE, TBW
Platyhypnidium riparioides (Hedw.) Dix. (Miners Falls, Steere 1934)
Pleurozium schreberi (Brid.) Mitt. [JG13250] GP, KL, LB, LBL, SMC, TBE, TBW
Pogonatum dentatum (Brid.) Brid. (gravelly lake bluffs, Nichols 1933; Conard 1938)
Pohlia annotina (Hedw.) Lindb. (Miners Castle, Crum & Miller 1967)
Pohlia elongata Hedw. var. *elongata* (Munising Falls, Miners Falls, Steere 1934)
Pohlia nutans (Hedw.) Lindb. [JG13259] HL, KL, SMC, SML, TBE
Pohlia proligera (Kindb. ex Breidl.) Lindb. ex Arnell (Crum & Miller 1967)
Pohlia wahlenbergii (Web. & Mohr) Andrews (crevices of cliffs, Nichols 1933) [JG1170A] MB
Polytrichastrum alpinum (Hedw.) G. L. Sm. var. *alpinum* (woods along lake bluffs, Nichols 1933; Conard 1938) [JM1174] HL, TBE, TBW
Polytrichum commune Hedw. var. *commune* [JZ1021] LB, SML
Polytrichum juniperinum Hedw. (Grand Sable Dunes, Bach 1978) [JG13305] LB, MB, SMC, TBE, TBW
Polytrichum longisetum Brid. [JZ1221A] LL, SML
Polytrichum ohioense Ren. & Card. [JZ1203A] HL, KL, LBL, SMC, SML, TBE
Polytrichum pallidisetum Funck [JZ1119A] GP, HL, LL, SMC, SML
Polytrichum piliferum Hedw. [JG13248] GP, KL, SMC, TBE
Pseudobryum cinclidioides (Hüb.) T. Kop. (Grand Sable Dunes, Bowers 1987)
Pseudoleskea radicosa (Mitt.) Mac. & Kindb. (Grand Sable Dunes, Bowers 1987)
Ptilium crista-castrensis (Hedw.) De Not. [JG13251] KL, TBE, TBW, SMC
Pylaisiella selwynii (Kindb.) Crum et al. [JG13211] BL, KL, LB, LBC, SMC, TBE, TBW
Racomitrium canescens (Hedw.) Brid. var. *canescens* (Grand Sable Dunes, Bach 1978) [NP265] GP
Rhabdoweisia crispata (With.) Lindb. [JG13426] KL, MB
Rhizomnium pseudopunctatum (Brunch & Schimp.) T. Kop. (Grand Sable Dunes, Bowers 1968)
Rhizomnium punctatum (Hedw.) T. Kop. [NP222] MB, SMC, SML
Rhytidiadelphus triquetrus (Hedw.) Warnst. (Grand Sable Dunes, Bach 1978) [JZ1165] LB, LBC, MB, TBE
Saelania glaucescens (Hedw.) Broth. in Bomanss. & Broth. [JZ1174B] KL, MB
Sanionia uncinata (Hedw.) Loeske var. *uncinata* [JZ1090] KL, LB, MB, SMC, TBE, TBW
Schistidium apocarpum (Hedw.) Bruch & Schimp. in B.S.G. (Miners Castle, Richards 1952)
Scopelophila ligulata (Spruce) Spruce (sandstone outcrop, Miners Castle, Crum & Miller 1968)
Seligeria donniana (Sm.) C. Müll. (Miners Falls, Steere 1934)
Sphagnum angustifolium (C. Jens. ex Russ.) C. Jens. in Tolf [JG13415] KL
Sphagnum capillifolium (Ehrh.) Hedw. [JG13346] KL, SMC

TABLE 1. (Continued)

Sphagnum centrale C. Jens. in Arnell & C. Jens. [JG13385] KL
Sphagnum cuspidatum Ehrh. ex Hoffm. [JG13401] KL
Sphagnum fallax (Klinggr.) Klinggr. [JG13402] KL
Sphagnum fimbriatum Wils. in Wils. & Hook. f. in Hook. f. (Conard 1938)
Sphagnum girgensohnii Russ. [JG13398] KL
Sphagnum papillosum Lindb. [JG13411] KL
Sphagnum rubellum Wils. [JG13413] KL
Sphagnum squarrosum Crome [JG13388] KL, LBC
Sphagnum wulfianum Girg. [JG13400] KL
Steerecleus serrulatus (Hedw.) Robins. [JG13245] BL
Tetraphis pellucida Hedw. [JG13368] BL, KL, LB, LBC, SMC, SML, TBE, TBW
Thuidium delicatulum (Hedw.) Schimp. in B.S.G. [NL1721] MB
Thuidium recognitum (Hedw.) Lindb. [JG13278] LB, MB, TBE
Tortula mucronifolia Schwaegr. [JG13441] MB, TBW
Ulota crispa (Hedw.) Brid. [NL1763] GP, HL, KL, LBC, SMC

LIVERWORTS
Anastrophyllum michauxii (Web.) Buch et Evans (gravelly lake bluff & cliff crevices, Nichols 1933)
Anthelia juratzkana (Limpr.) Trev. (Conard 1938; sandstone cliff, east of Miners Castle, Crum & Miller 1968)
Bazzania trilobata (L.) S. Gray [JG13351] HL, KL, LBC, LBL, SMC, TBE, TBW
Blasia pusilla L. (gravelly lake bluffs, Nichols 1933; Conard 1938)
Blepharostoma trichophyllum (L.) Dum. [JG5497] LBC
Calypogeja fissa (L.) Raddi [JG13230] LB, LBC
Calypogeja integristipula Steph. [JG5503] LBC
Calypogeja muelleriana (Schiffn.) K. Mull. [JG13279] TBE
Cephalozia bicuspidata (L.) Dum. (gravelly lake bluff, Nichols 1933)
Cephalozia lunulifolia (Dum.) Dum. [JG5519] LBL
Conocephalum conicum (L.) Lindb. (Miners Falls, Steere 1934) [JG5517] LBL
Frullania bolanderi Aust. (Conard 1938) [JG13222] GP, KL, LB, LBL, SMC, SML
Frullania eboracensis Gott. [JZ1097B] SMC
Jamesoniella autumnalis (DC.) Steph. [NP228] GP, KL, SMC, SML, TBE, TBW
Jungermannia exsertifolia subsp. *cordifolia* (Dum.) Vana (lake bluffs, Nichols 1933; Conard 1938)
Jungermannia hyalina Lyell (rock ledges along shore, Nichols 1933; Steere 1934)
Jungermannia leiantha Grolle (Conard 1938)
Jungermannia sphaerocarpa Hook. (sandstone cliff, Miners Castle, Crum & Miller 1968)
Lepidozia reptans (L.) Dum. [JZ1033A] BL, KL, LBC, TBE, TBW
Lophocolea heterophylla (Schrad.) Dum. [JZ1046] KL, LB, LBL, SML, TBE
Lophocolea minor Nees [JG13444] MB
Lophozia alpestris (Schleich. ex Web.) Evans (gravelly lake bluffs, Nichols 1933)
Lophozia attenuata (Mart.) Dumort. [JZ1082] KL, TBE, TBW
Lophozia badensis (Gott. ex Rabenh.) Schiffn. (gravelly lake bluffs, Nichols 1933; Conard 1938)
Lophozia gillmanii (Aust.) Schust. (gravelly lake bluffs, Nichols 1933)
Lophozia ventricosa (Dicks.) Dumort. (base of cliffs, Nichols 1933)
Pellia epiphylla (L.) Corda (gravelly lake bluffs, Nichols 1933)
Plagiochila porelloides (Torrey ex Nees) Lindenb. [JG5515] LBL
Porella platyphylla (L.) Pfeiff. [JG13234] BL, LB, SML
Preissia quadrata (Scop.) Nees (Miners Castle, Richards 1952) [JZ1164] KL, MB
Ptilidium ciliare (L.) Hampe [JG13301] HL, KL, TBE, TBW
Ptilidium pulcherrimum (G. Web.) Hampe [JG13366] BL, KL, LB, LBL, SML, TBE, TBW
Radula complanata (L.) Dum. [JG1323] BL, LB, SML
Scapania irrigua (Nees) Gott. *et al.* (rock ledges, Nichols 1933)
Scapania nemorosa (L.) Dum. (Steere 1934)
Scapania saxicola Schust. (sandstone cliff, east of Miners Castle, Crum & Miller 1968)
Trichocolea tomentella (Ehrh.) Dum. [JG5487] LBC
Tritomaria exsecta (Schrad.) Loeske (gravelly lake bluff, Nichols 1933)

with over 400 mosses and liverworts reported for the state of Michigan. The bryophyte flora is described below based on the vegetation types according to the 1980 NPS Assessment of Alternatives for Pictured Rocks National Lakeshore, with locations noted on Figure 1. The corridor represents only a small percentage of the likely taxa in the park because it is mostly forested and lacks the habitats that are rich in species. The alkaline wetlands may harbor taxa that occur nowhere else in the Upper Peninsula, and because of their northern location may harbor taxa that are unknown elsewhere in the state. Furthermore, the most interesting and unusual habitats are the alkaline sandstones along the rocky shore, and these have barely been explored by any bryologists. A boat trip along the cliffs could reveal some very interesting finds.

Lake shoreline

Bryophytes of the lake shoreline grow in a unique habitat affected by both the lake and the forest. Relatively more diverse microhabitats are found in this area. Near the road between Twelvemile Beach Campground and the parking area about 1 km to the east (TBE) there are three types of habitats: foredune, valley between dunes, and second dune. The dune face is a very unstable habitat and the only species found there abundantly is *Polytrichum piliferum* (Fig. 2). This species is a widely distributed moss and most commonly grows in disturbed, exposed, and dry habitats. In the Netherlands, it is an important component on inland dunes (Plius 1994) and on the shores of Lake Superior it plays an important role in dune stabilization (Marsh & Koerner 1972). Bach (1978) also found *Brachythecium salebrosum, Dicranella heteromalla, Ditrichum flexicaule, Racomitrium canescens, Rhytidiadelphus triquetris,* and *Polytrichum juniperinum* on the park dunes, but did not report any *Polytrichum piliferum*. Mosses such as these are able to trap blowing sand, thus helping to stabilize the dunes (Schulten 1985)

At the top of the dune there is an overstory including *Pinus resinosa*, *Betula papyrifera*, *Acer saccharum*, and other hardwood and coniferous trees. On the forest floor the common bryophytes *Brachythecium oxycladon, B. velutinum* var. *velutinum*, *Callicladium haldanianum*, *Dicranum scoparium*, *D. montanum*, *D. polysetum*, *Ptilium crista-castrensis*, *Sanionia uncinata*, and *Pleurozium schreberi* are frequently found; on tree bases *Brachythecium reflexum*, *Dicranum viride*, and *Hypnum pallescens*; and on rotten logs *Brotherella recurvans*, *Lophocolea heterophylla* (liverwort), and *Ptilidium pulcherrimum* (liverwort).

The valley between the foredune and second dune is a habitat with more shade and taller trees. The overstory is dominated by *Acer saccharum*, *Betula papyrifera,* and occasionally *Pinus resinosa*. The understory is mostly *Pinus strobus* saplings. The forest floor is covered by such vascular plants as *Gaultheria procumbens*, *Maianthemum canadense*, *Lycopodium clavatum*, *Pteridium aquilinum*, *Trientalis borealis*, and *Vaccinium* sp. Bryophytes are more abundant in the protective microhabitat of the valley than on the foredune. One of the noticeable habitat differences from that of the foredune is that there are more rotten logs and stumps and a thicker litter layer in the valley. Among the bryophytes are those growing on rotten logs and stumps: *Callicladium haldanianum*, *Bazza-*

FIGURE 2. Shoreline along Twelvemile Beach, Pictured Rocks National Lakeshore, Alger County, Michigan, showing *Polytrichum piliferum* creating small hummocks (see arrow) that stabilize the beach. Photograph by the author, late May, 1991.

nia trilobata (liverwort), *Brotherella recurvans, Lophocolea heterophylla* (liverwort), *Lepidozia reptans* (liverwort), *Plagiothecium laetum, Sanionia uncinata*, and *Tetraphis pellucida*; species found on soil: *Dicranum scoparium, Hypnum pallescens, Ptilium crista-castrensis, Platygyrium repens, Thuidium recognitum,* and *Barbilophozia attenuata* (liverwort).

On sandy soil at the top of the second dune, in addition to the species found on the foredune, are *Brachythecium salebrosum, Hylocomium splendens, Hypnum imponens, Plagiomnium cuspidatum, Plagiothecium laetum,* and *Rhytidiadelphus triquetrus.*

Coniferous forest

A Jack pine forest *(Pinus banksiana)* was sampled about 1 km south of the parking area just east of Twelvemile Beach Campground (TBW). This is an open and dry habitat with a few *Acer saccharum* saplings in the understory. The ground is covered sparsely by the lichens *Cladina* spp. and *Cladonia* spp., and vascular plants *Epigaea repens, Maianthemum canadense, Pteridium aquilinum,* and *Vaccinium* sp. The habitat is uniform, with few bryophyte taxa, the representative ones being *Dicranum flagellare, D. fuscescens, D. montanum, D. polysetum, D. scoparium, Plagiothecium cavifolium, Pleurozium schreberi, Polytrichum juniperinum,* and *Ptilium crista-castrensis.*

Hardwood forests

The hardwood forest, associated with few coniferous trees, was sampled at several locations: LB, BL, HL, LL, SML (See Table 1). The habitat is more shady and moist than the coniferous forest, with a dominant overstory of *Acer saccharum, Fagus grandifolia*, and *Acer pensylvanicum*; understory saplings include *Acer saccharum, Fagus grandifolia*, and *Acer pensylvanicum*; the sparse ground cover includes vascular plants *Actaea* sp., *Aralia nudicaulis, Claytonia caroliniana, Dicentra* spp., *Carex* spp., *Clintonia borealis, Dryopteris intermedia, Erythronium americanum, Lycopodium* (*sensu lato*) spp., *Maianthemum canadense, Milium effusum, Mitchella repens, Osmorhiza* spp., *Oxalis* sp., *Sambucus pubens, Smilacina racemosa, Trientalis borealis*, and *Viola* sp.

There are more species of bryophytes in the hardwood forest than in the coniferous forest. Forest floor taxa include *Amblystegium varium, Bazzania trilobata* (liverwort), *Brachythecium* sp., *B. reflexum, Callicladium haldanianum, Dicranella heteromalla, Dicranum scoparium, Hypnum pallescens, Mnium thomsonii, Plagiothecium* spp., and *Jamesoniella autumnalis* (liverwort); on tree bases and tree bark, *Brachythecium reflexum, Frullania bolanderi* (liverwort), *Hypnum pallescens, Leskeella nervosa, Orthotrichum* sp., *Platygyrium repens, Porella platyphylla* (liverwort), *Ptilidium pulcherrimum* (liverwort), and *Pylaisiella selwynii.*

Mixed hardwood and coniferous forests

The mixed hardwood and coniferous forest is a widely distributed major vegetation type in the park. We sampled two major locations: SMC and KL (See Table 1). The overstory species are represented by *Abies balsamea, Acer saccharum, Betula papyrifera, Fagus grandifolia,* and *Tsuga canadensis*; understory by saplings of *Acer pensylvanicum* and *A. saccharum*; and ground cover by *Aralia nudicaulis, Coptis trifolia, Dryopteris intermedia, Lycopodium* spp., *Maianthemum canadense, Oxalis* sp., and *Trientalis borealis*. The habitat characters and bryophyte species of this type of forest are not very different from those of the hardwood forest, with common forest floor taxa including *Brachythecium* sp., *B. reflexum, Callicladium haldanianum, Ceratodon purpureus, Climacium dendroides, Dicranum flagellare, D. montanum, D. scoparium, D. viride, Hypnum pallescens, Plagiomnium cuspidatum, Plagiothecium* spp., *Pleurozium schreberi, Pohlia* spp., *Tetraphis pellucida,* and the liverworts *Bazzania trilobata, Jamesoniella autumnalis, Lepidozia reptans,* and *Lophocolea heterophylla*; *Brotherella recurvans, Frullania bolanderi* (liverwort), *Neckera pennata, Orthotrichum speciosum, Platygyrium repens,* and *Ptilidium pulcherrimum* (liverwort) occur on bark.

Wetlands

Wetlands have been particularly important for special concern, threatened, and endangered vascular plants in the park (Crispin et al. 1984). We sampled several wetlands west of the trail from Twelvemile Beach to Kingston Lake

Campground (KL) where the overstory is dominated by *Betula alleghaniensis*, *Larix laricina*, *Picea mariana*, and *Tsuga canadensis*, and the groundcover by *Andromeda glaucophylla*, *Chamaedaphne calyculata*, *Eriophorum* sp., *Kalmia polifolia*, *Ledum groenlandicum*, and *Vaccinium* sp. (cranberry). Ten species of *Sphagnum* were identified: *S. angustifolium*, *S. capillifolium*, *S. centrale*, *S. cuspidatum*, *S. fallax*, *S. girgensohnii*, *S. papillosum*, *S. rubellum*, *S. squarrosum*, and *S. wulfianum*.

Near parking lots and trail entrances

The open, sandy habitat of the borders of parking lots and entrances to trails harbors a small group of light-tolerant, short mosses. These generally include *Barbula* spp., *Bryum argenteum*, *Bryum* spp., and *Ceratodon purpureus*.

Rock cliffs at Miners Beach Falls

Miners Beach Falls (MB) is on seepy rock cliffs next to Lake Superior. Because of its diverse microhabitats and topography it is the most interesting place to find many rare and unusual bryophytes that were scarcely found elsewhere in the park. Aquatic and wet habitat species included *Brachythecium rivulare*, *Cratoneuron filicinum*, *Hygroamblystegium fluviatile*, *Hygrohypnum luridum*, *Lophocolea minor* (liverwort), *Philonotis fontana*, *Pohlia wahlenbergii*, *Preissia quadrata* (liverwort), *Rhizomnium pseudopunctatum* (considered by Bowers, 1968, to be rare in the Upper Peninsula), and *R. punctatum*. Other interesting species found on sandstone here are *Barbula convoluta*, *Bryoerythrophyllum recurvirostre*, *Desmatodon obtusifolius*, *Dichodontium pellucidum*, *Encalypta ciliata*, *Funaria hygrometrica*, *Gymnostomum aeruginosum*, *Hymenostylium recurvirostre*, *Leptobryum pyriforme*, and *Saelania glaucescens*.

Interesting and rare species

Buxbaumia aphylla (Bug-on-a-stick) was found in the park for the first time, on the trail from Twelvemile Beach to Kingston Lake Campground on a steep, sandy southwest-facing hillside (KL) that is a deforested site with a few *Populus* trees scattered on the mostly unvegetated, sandy slope. Ground cover is mostly the lichens *Cladina* and *Cladonia* spp., and mosses *Bryum* sp., *Ceratodon purpureus*, *Dicranum montanum*, *Pleurozium schreberi*, *Plagiomnium ciliare*, and *Polytrichum piliferum*. *Buxbaumia aphylla* also occurs beside the trail near the beach south of the mouth of Sevenmile Creek. *Buxbaumia aphylla* has been found abundantly in several localities in Houghton, Keweenaw, and Baraga Counties in Upper Michigan, but has appeared on the working lists for protection in both Wisconsin (1993, unpub.) and the US Forest Service Globally Rare for USA and Canada (1996). It is a pioneer of disturbed, acid, sandy or clayey soil, often on the banks of roads or in woodlands, exposed or in partial shade in moist forest and also dry, open woods, often successional to fire.

Another species that has a morphology somewhat similar to that of *Buxbaumia* is *Diphyscium foliosum* (grain of wheat moss). This dioecious moss was

found only in a sample along the trail to Little Beaver Campground about 3 km southeast of Beaver Lake (LB). Although seemingly rare in the park, the species is common in the Upper Peninsula. *Diphyscium* usually grows on shaded soil or humus, especially on the banks of woodland trails. This time we only found the male gametophyte—a leafy plant with no capsule.

To the uncommon species reported in the literature, we have added the mosses *Anomodon minor, Didymodon rigidulus, Herzogiella striatella, Hylocomium umbratum, Polytrichum pallidisetum, Rhabdoweisia crispata, Sphagnum wulfianum,* and *Tortula mucronifolia*, and the liverwort *Calypogeja fissa* (Wisconsin Natural Heritage Working List 1993, unpub.), totalling 9 species. From the literature (see Table 1), we can include *Dicranella cerviculata* (Wisconsin Natural Heritage Working List 1993, unpub.), *D. grevilleana*, *Ditrichum flexicaule* (Wisconsin Natural Heritage Working List 1993, unpub.), *Hygroamblystegium noterophilum*, *Meesia triquetra* (noted by Crum 1973 as extremely rare), *Mielichhoferia mielichhoferiana* (a rare copper moss; Michigan Natural Features Inventory compilation, 1982 unpub.; U. S. Forest Service Working Copy, 1996 unpub.), *Pohlia annotina, Pogonatum dentatum*, *Pseudobryum cinclidioides*, *Pseudoleskea radicosa, Racomitrium canescens* (the latter confirmed by our collections), *Scopelophila ligulata* (found only in this one collection in Michigan), and *Seligeria donniana* (Wisconsin Natural Heritage Working List 1993, unpub.) as rare or uncommon. To the liverworts, we can add from the literature *Anastrophyllum michauxii, Anthelia juratzkana, Jungermannia exsertifolia* subsp. *cordifolia* (Wisconsin Natural Heritage Working List 1993, unpub.), *J. hyalina, J. sphaerocarpa, Lophozia alpestris, L. badensis, L. gillmanii, L. ventricosa*, *Scapania irrigua,* and *S. saxicola* (known from one other collection in Michigan; Wisconsin Natural Heritage Working List 1993, unpub.). Most of these liverworts are not known from the Lower Peninsula. However, of these bryophytes only *Mielichhoferia mielichhoferiana* appears on the list of Rare Bryophytes of Michigan (Gereau & Crispin for Michigan Natural Features Inventory, 1982 unpub.).

Herzogiella striatella is found on rotten birch logs associated with *Hypnum pallescens*, near the road between Twelvemile Beach Campground and the parking area about 1 km to the east. Being a northern species, it is unknown in the Lower Peninsula, but occurs at Tahquamenon Falls (Crum 1973). It is not common in the Upper Peninsula.

Hylocomium umbratum, found in 1982 in the forest at Little Beaver Lake, is otherwise known in Michigan only from Tahquamenon Falls and one other site. *Plagiomnium ciliare* seems to be known in the Upper Peninsula only from Chippewa and Ontonagon Counties (Darlington 1964). *Pseudoleskea radicosa* is thus far known only from Keweenaw and Ontonagon Counties and Pictured Rocks in Michigan (Darlington 1964). *Calypogeja fissa* is previously known from only one locality in the Upper Peninsula, in the Keweenaw Peninsula (Glime & Slavick 1985).

Other uncommon species found in the park are *Ditrichum flexicaule* at Grand Sable Dunes (Bach 1978), and *Leptobryum pyriforme* (BL). The species of *Ditrichum* and *Leptobryum* occur in disturbed habitats and therefore their habitat cannot easily be preserved; although not rare, they are not common in

the Upper Peninsula. Pictured Rocks (at about 1 km south of the mouth of Sevenmile Creek, near NPS boundary markers on trees; SMC) and the sand barrens of Schoolcraft County seem to be the only published locations for *Polytrichum pallidisetum* in Michigan, although Crum & Anderson (1981) reported it as common in the Great Lakes area. *Racomitrium canescens* grows on sandy soil; although it is very widespread in the northern hemisphere, it is uncommon in Michigan. We found it only along the road from road H58 to the parking area about 3 km southeast of Beaver Lake, gravel pit north of the road (GP).

CONCLUDING REMARKS

The bryophyte flora of the Pictured Rocks National Lakeshore is a protected habitat overlying alkaline sand. As a result, several species occur here that are difficult to find elsewhere. Most of these somewhat rare taxa are to be found on the lakeshore among the calcareous sandstone cliffs, but a few are found on the sandy forest soils, wetlands, and elsewhere.

Another habitat with less common species is the bog/fen system. Among the bryophytes in this habitat, *Sphagnum wulfianum* is uncommon in the Upper Peninsula. Many wetlands exist in the park and remain to be explored for rare bryophytes.

The lakeshore habitat, especially along the trail from Twelvemile Campground west, should be preserved. This beach area now has a beautiful hiking trail with numerous orchids, including a large, dense patch of *Cypripedium acaule*, among others, and the bryophytes *Tortula mucronifolia* and *Buxbaumia aphylla*. It is likely that many more bryophytes exist in the park but have never been identified. It would be beneficial from a phytogeographical perspective to do a thorough survey of the entire park to document those taxa that might be living in this unusual alkaline habitat in the transition between the boreal forest and the mixed deciduous forest typical further south. Pictured Rocks National Lakeshore represents a unique location not only in Michigan, but also in the United States, where one can find northern alkaline species. The Lake Superior Basin harbors many interesting species that seem to be disjunct from western communities, and surely many of these disjunct taxa remain to be discovered along the sandstone cliffs and in the wetland areas of Pictured Rocks National Lakeshore.

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NOTEWORTHY COLLECTION

MICHIGAN

Juncus ensifolius Wikstr. (Juncaceae). Iris-leaved or Three-stamened Rush.

Previous knowledge. In North America, this species ranges from Alaska to Saskatchewan south to California and Mexico, with disjunct populations in Wisconsin, New York, Ontario, and Quebec (Clemants 2000). Judziewicz & Nekola (1997) note that Hugh Iltis found the first Midwest occurrence in Ashland County, Wisconsin, in 1971. They also state that this rush, growing in roadside ditches, is not native to Wisconsin, but is introduced from western North America. *Juncus ensifolius,* which is native in Montana, has a "potential for weediness" in that state and elsewhere (http://gemini.oscs.montana.edu/~mlavin/herb/ripweed.htm; accessed 2/13/01). In New York, *J. ensifolius*, in addition to growing along the Delaware River, occurs in a roadside ditch (New York Natural Heritage Program element tracking record, 2001). Although this species is considered native in New York and designated state-endangered, Clemants notes that it is "probably introduced" in that state. At present, *J. ensifolius* has no conservation status in Michigan. This species is also known as *Juncus xiphioides* E. Meyer var. *triandrus* Engelm., but according to Clemants (2000), "until a study of the complete subgenus is done, we [that is, Steven E. Clemants and his co-author for the entire treatment of the Juncaceae, Ralph E. Brooks] are hesitant to use a varietal name (*J. xiphioides* var. *triandrus*) for the widespread western taxon *J. ensifolius*."

Significance. These collections document the occurrence of *Juncus ensifolius* in Michigan. No collections had been made before Voss' (1972) Flora of Michigan.

Diagnostic characters. *Juncus ensifolius* is the only species in the genus *Juncus* in eastern North America having leaves that are equitant (i.e., with the margins of the blade connate to form an edge facing the stem, like an iris).

ONTONAGON CO.: in gravel pit, in Ottawa National Forest, Forest Road 655-C, T50N R40W Sec. 25, 28 June 1993, *Hoefferle 124*. (Specimen found August 2001 in Ottawa National Forest Herbarium, mis-identified.) Associates include *Juncus effusus* L., *J. brevicaudatus* (Engelm.) Fern., *Carex stipata* Muhl.

ONTONAGON CO.: alongside sandy road on edge of adjacent open wetland with graminoids and exotics, Ottawa National Forest, Forest Road 1700, T50N R37W Sec. 22/27 section line, E ½, 8 August 2000, *Trull 385* (MICH, ! A.A. Reznicek). Abundant, scattered pockets on both sides of the road and back into natural wetland, but not in standing water. Associates include *Carex crinita* Lam., *C. stipata* Muhl., *Calamagrostis canadensis*(Michx.) P. Beauv., *Equisetum fluviatile* L., *Scirpus atrovirens* Willd., *Juncus effusus* L., *Rubus idaeus* L., *Alnus incana* (L.) Moench, *Onoclea sensibilis* L., *Ranunculus recurvatus* Poiret, *Phleum pratense* L., *Dactylis glomerata* L., *Chrysanthemum leucanthemum* L., *Melilotus alba*

Medikus, *Trifolium* spp., *Lotus corniculatus* L., *Achillea millefolium* L., *Plantago lanceolata* L.

SCHOOLCRAFT CO.: edge of trail at base of steep south-facing slope with 1–2 m high *Fagus grandifolia* Ehrh. saplings, Hiawatha National Forest, Big Island Lake Wilderness, T44N R18W, 14 August 2000, *Marr 2830* (MICH, !A.A. Reznicek). About 200 plants in a 4 × 9 m colony at the edge of an *Acer saccharum* /*Fagus grandifolia* forest and sedge-dominated wetland opening. Associates include *Equisetum sylvaticum* L., *Geum* sp., *Impatiens capensis* Meerb., *Lycopus uniflorus* Michx., *Plantago* sp., and *Solidago gigantea* Aiton.

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—JANET KEENEY MARR
23180 Highway Location Road
Calumet, Michigan 49913 USA
and
SUSAN J. TRULL
Ottawa National Forest
E6248 US2
Ironwood, MI 49938 USA

CONTENTS

On the cover: *A typical woodland scene in so much of the Great Lakes area; this is Harms Woods in northeastern Illinois, featuring* Trillium grandiflorum *in the understory. The photo was taken by William C. Burger (now retired from the Field Museum in Chicago) on 3 May 1998.*

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Inquiries about back issues and institutional subscriptions may be addressed to the Business Manager for The Michigan Botanist: J. Dan Skean, Jr., Department of Biology, Albion College, Albion, MI 49224; 517. 629. 0525 (office); 517. 629. 2356 (home); fax at 517. 629. 0888, e-mail at dskean@albion.edu.

Address changes should be directed to James Doyle, 631 Covell Avenue NW, Grand Rapids, MI 49504; 616. 459. 8281 (office); 616. 453. 5407 (home); jdoyle59@attbi.com

On all editorial matters, please contact: Neil A. Harriman, Editor, Biology Department, University of Wisconsin-Oshkosh, Oshkosh, WI 54901; 920. 424. 1002 (office); or at 5188 Bittersweet Lane, Oshkosh, WI 54901; 920. 233. 1973 (home); harriman@uwosh.edu – please use e-mail whenever possible.

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Membership Committee Chairperson: James Doyle, 631 Covell Avenue NW, Grand Rapids, MI 49504; 616. 459. 8281 (office); 616. 453. 5407 (home); jdoyle59@attbi.com (for state members; for chapter members, contact the Chapter Presidents below).

Huron Valley Chapter: Larry Nooden, Biology Department, University of Michigan, Ann Arbor, MI 48109; ldnum@umich.edu

Red Cedar Chapter: Jason Kilgore, 6916 Richard Street, Lansing, MI 48911; 517. 355. 5076 (office); 517. 272. 9737 (home); kilgore@msu.edu

Southeastern Chapter: Kathleen Thomson, 5066 Elmhurst, Royal Oak, MI 48073; 248. 435. 2070

Southwestern Chapter: Ken Kirton, 121 Woodwind Circle, Kalamazoo, MI 49006; ktkirton@aol.com

White Pine Chapter: Dorothy Sibley, 7951 Walnut Avenue, Newaygo, MI 49337; dsibley@mail.riverview.net

A BOTANICAL SURVEY OF THE WHITE PINE TRAIL STATE PARK (RAILS-TO-TRAILS) IN MECOSTA COUNTY, MICHIGAN, WITH EMPHASIS ON ALIEN AND MEDICINAL PLANTS

Stephen Ross
16809 125th Avenue
Rodney MI 49342-9706
rosssb@tucker-usa.com

Robert J. Krueger
College of Pharmacy, Ferris State University
Big Rapids MI 49307
robert_j_krueger@ferris.edu

ABSTRACT

Five old railroad corridors are present in Michigan as State Parks or Rails-to-Trails projects. These corridors have been left relatively undisturbed for 20 or more years since the abandonment of the railroads. Though many plant species are known to be characteristic of roadways, railroad rights-of-way, and similar disturbed sites, we could find no study to date characterizing the flora along these old rail routes in Michigan. This paper takes the first systematic look at the flora of a section of one of these trails, namely the White Pine Trail State Park that runs through Mecosta County in west central Michigan. This was the first major route for the introduction of invasive species to this area during and after the logging era (1845–1910 in Mecosta County) and into the settlement period (1855–1900). We provide a list of 491 species of plants found within the trail right-of-way through Mecosta County, and discuss the presence and absence of alien plants and species of medicinal value found along the route. We also speculate about the absence of a number of invasive species that seem conspicuously missing from the trail.

INTRODUCTION

The White Pine Trail is a Michigan State Park located in west-central Michigan, running from Comstock Park, north of Grand Rapids, to Cadillac. The trail is approximately 92 miles long and varies between 50–200 feet wide. In Mecosta County, the park is about 25 miles long, and varies from barely wider than the rail bed in some of the city locations to about 150 feet wide. It runs through the eastern edge of Aetna, Mecosta, Big Rapids, and Green townships and touches the northwestern corner of Deerfield, northwestern and southwestern corners of Austin and the southwestern corner of Colfax townships. The railroad right-of-way was purchased from the railroad by the State of Michigan Department of Transportation in 1991, and obtained by the Department of Parks and Recreation in the spring of 1994. The trail was dedicated on 20 July 1994, after a number of improvements which continue today (E. Fransen, Park Superintendent, pers. comm.). Because this corridor has been left reasonably intact for many years, there is some value to making a survey of the plant species (including plants of medicinal value particularly those that may be of commercial value) and therefore in danger of being collected, and to survey non-native and invasive plants.

And finally, we wished to apply to this survey what E. O. Wilson recently outlined in his “Workable strategy for halting the loss of species” commentary:

"to render conservation [of the White Pine Trail] both exact and maximally cost effective, [one must] complete the mapping of the [Trail's] biodiversity" (Wilson 2002). Simply stated, one doesn't know what has been lost without knowing what was originally present.

History

There has been a long history of movement of plants alien to this hemisphere. Starting as early as Columbus' second voyage, horses were landed on New World soil, along with fodder necessary to feed them. The dumping of shipping ballast all along the eastern seaboard, from the Caribbean to Newfoundland, over centuries of exploration and trade brought many of our most common and noxious weeds (Cox 1999; Crosby 1986). Some common species have been in the Americas much longer than generally thought: White Clover (*Trifolium repens*) arrived in the 1500s, Purple Loosestrife (*Lythrum salicaria*) by the late 1700s, and Multiflora Rose (*Rosa multiflora*) by 1811 (Cox 1999; Crosby 1986). Some others were present at the time of the first floral survey of Michigan in 1837 (Darlington 1918; Voss 1972, 1985, 1996); and *Rumex acetosella*, *Pastinaca sativa*, *Leonurus cardiaca*, and *Arctium minus* (Voss 1972, 1985, 1996) were all present in the state by 1839. Many alien plants have been here so long that many people think of them as native. Westward expansion of people and plants into the Great Lakes region was minimal until the opening of the Erie Canal (1825) and Great Lakes shipping. Mass movement of European immigrants and cargo opened the door of Michigan to plants deliberately or unintentionally carried in the canal-boat and sailing-ship ballasts and dumped at the end of voyages (Cox 1999). Immigrants often carried plants and seeds familiar and useful to them. Plant acclimatization societies also introduced many non-native plants to North America. There is some evidence that the Native Americans did move some plants accidentally as well as intentionally around the state in trade and indigenous agriculture, but none that can be directly traced to Native American activity in Mecosta County. There was no known permanent Native American settlement in Mecosta County prior to the arrival of Europeans.

The Pre-settlement Map (MIRIS) of Mecosta County (Comer et al. 1995) indicates that the area of the county through which the White Pine Trail State Park now runs was entirely forested with beech-maple (apparently in climax, as understory of beech-maple is noted several times), pine, hemlock, ironwood, basswood, some ash and a bit of aspen. Oaks are noted as White Oak (*Quercus alba*) and Black Oak (*Quercus velutina*), or referred to as just oak, and they appear to be a minimal percentage of the full surrounding forest. The Black Oak is almost entirely confined to the "barrens" of the Coloma and Coloma-Coveret-Thetford soil associations in the sandy soils of the Muskegon-Little Muskegon River outwash deposits (USDA 1981).

Mecosta County's European-influenced history began in the mid-1840s, as lumbering operations from Newaygo County began moving northeastward. These operations entered Mecosta County in Aetna Township and progressed northeastward across the area to the eastern townships over the next 40 years. White Pine was the main product, as it could be moved relatively easily by way

of the several river systems, principally the Muskegon and Little Muskegon Rivers, and because it was the only local wood that could be floated. Travel to the county by early roads was an ordeal, taking as much as six days by wagon from Grand Rapids (approximately 70 miles) by way of Newaygo. In the 1850s and 1860s, Big Rapids grew from a collection of huts around a sawmill to a small town. Other small communities in the county such as Morley, Stanwood, Borland, and Byers, as well as Crapo and Reed City in Osceola County, created a demand for rail service. The railroad's primary functions were to remove timber; bring in supplies, forage, and livestock to the lumber camps and early farms; and to carry passengers and settlers into the area.

Cedar, hemlock, ash, maple, and oak could only be removed with rail service, as none of these woods would float. Lumbering operations began harvesting these previously ignored or "trash" species when the railroad became available. The Grand Rapids and Indiana Company was formed to provide that service, and track reached Morley by 1869 and Big Rapids in June, 1870. Rail operations reached their peak about 1900 and declined steadily afterward, with only a short revival in the 1930s and 1940s as tourist trains (Dunbar 1969), ceasing operations in the mid-1980s. The rails remained abandoned for several years until Rails-to-Trails project began to turn the right-of-way into a state park.

We were unable to locate any local persons who could elaborate on rail operations in the area that would have affected the plant life within the right-of-way boundary. It was obvious in the growth of aspens, oaks, cherries, and maples that some clearing was done in the right-of-way during the latter days of rail service. Some new successional growth from older woodlot stands adjoining the right-of-way then made incursions into the area. Also noted were many oak, maple, and linden trees, both individually and in woodlots and in the right-of-way, about 70-80 years of age or more, with many others in the area of 40–50 years of age (based on personal observations of comparing tree-ring counts on cut trees in the county, SR).

While some of the list's weeds may have first entered the county along the rugged early roads, falling from hay wagons or from draft animals (fur, hooves, defecations), the railway was the prime entry route for invasive weeds. A large number of our general weed species, such as *Barbarea vulgaris*, *Melilotus alba* and *M. officinalis*, *Hypericum perforatum*, *Cichorium intybus*, and *Cirsium arvense* (Darlington 1918), entered the county by way of the early state road and rail transport in hay brought in for the draft animals, their bedding in rail cars, animal fur, contaminant seeds, and as garden plants. Several other introduced species are found only along the rail bed (*Acinos arvensis, Chaenorrhinum minus, Tradescantia ohiensis*), as the bed provides the only limestone in the county for calciphile plants, with the exception of the recent usage of crushed limestone in roadwork.

Some more recent weed arrivals that entered the county are *Abutilon theophrasti* and *Pastinaca sativa* as contaminants in agricultural seed. *Abutilon* was observed in a farm field along the trail in 1996 and is spreading rapidly through the county's farming community, but has not yet appeared on the trail proper, while *Pastinaca* is rapidly spreading along the trail from a point of origin probably between 6 and 7 Mile Roads. *Sonchus arvensis* is common along

nearby roadsides and probably spread by vortex wind from passing vehicles, but so far is represented on the trail by only a few plants. *Elaeagnus umbellata* is a shrub widely planted by the Department of Natural Resources (DNR; the practice stopped in 2000) and offered by the Soil Conservation Service for wildlife plantings (the practice stopped in 1999). The berries are widely disseminated by birds (mostly by European Starlings *Sturnus vulgaris*) and the shrub is becoming widely established along the trail as well as overtaking old fields throughout the county. The origin of *Alliaria petiolata* here is not known, as the only known plants in the county were found in two widely separated locations on the trail during this study.

Habitats

During their early days, railroad rights-of-way were routinely burned to keep down weeds and woody vegetation. As communities built up along the trail and mechanical mowing devices became available, fire clearing was discouraged. About 1930, when effective fire-protection and suppression equipment became available to communities and counties for safety and property-value reasons, fires no longer were used as a means of clearing. Until that time, unintended fires started by sparks from the engines, brakes, and off-track slash fires (such as those that swept much of Michigan in the 1880s) also burned beyond rights-of-way and into adjacent properties (Curtis 1959, p. 306). Other factors due to railway work, maintenance, topography, and erosion also created disturbed areas along the railway corridor. Such work and fires left a patchwork of vegetation along the corridor. Native plants adapted to fire would easily resprout if not burned too severely, and formed a buffer between the railroad and adjoining agricultural land (Curtis 1959, p. 306).

The trail as a whole is a variety of recently disturbed sites (road crossings, trail signage, paving), occasionally disturbed (edge mowing), open areas characteristic of old fields, established shrub borders with second growth, and a few fairly old, stable habitats. Most of the shrub borders and early second growth near the trail bed show some signs that cutting and trimming from fence to fence on the flat areas has occasionally occurred in the past 20 or so years. The most stable and oldest habitats border the fence lines well away from the rail bed, as well as along the steep banks, streamsides, and marshy areas. Some of the oldest trees probably approach 60 to 100 years of age, with a well-established understory of shrubs, trees, and lush herbaceous layers. These areas are small and few along the trail and associated with larger off-trail woodlots. A viewing of the whole trail on the county aerial photos (1999) in the Paris Wildlife Office files gives the appearance of the trail being one long, intermittent hedgerow. The trail passes through approximately 4.0 miles of city- and town-altered landscape (Morley, Stanwood, Big Rapids and Paris), with the majority of the rest of the trail being in a wide variety of successional states.

Several unusual plant habitats occur within the rail right-of-way that are not present (or quite limited) elsewhere in the county. These are:

1. Many locations on the central rail line are underlaid by limestone that occurs nowhere else in the region except for recent state and county roadwork;
2. Several rail sidings contain significant amounts of high-sulfur cinders (Big Rapids, Maple Street northward to a bit north of Baldwin Street; Stanwood; Byers; Borland; and Morley);
3. Farm-supply businesses along the trail (Stanwood and Big Rapids) and rail stations, where on- and off-loading of grains occurred, show higher concentrations of weeds than elsewhere on the trail (*Arabidopsisthaliana*, *Thlaspi arvense*, *Lepidium virginica*, *Camelina microcarpa, Viola arvense*, and *Ambrosia trifida* were only found in these locations);
4. A hillside seep and a swamp area about 0.25–0.75 mile south of Paris; and
5. A small, limey, damp-to-wet area 0.375 mile north of Angling Road.

METHODS

The entire length of the trail was surveyed three times during 2001; 14 May–9 June, 3–26 July, and 10–29 September. The trail was divided into 10 segments (below) of similar habitat characteristics. Each segment was surveyed from fence to fence, and only species within the trail proper were included. A list of all plants observed was kept for each segment of the trail, and then summarized for the master list used in this paper. Some judgment had to be used, as the trail is not fully fenced due to a number of open boundaries with adjoining properties. In such situations, what appeared to be the most likely old fence line or property line was used. Also, in several city residential and city-maintained areas, lawns are mowed to the rail bed. An area directly behind the Stanwood Feed and Needs store (southwest corner of Jefferson at Front streets) from the building to the trail is not mowed, and certainty of property ownership is not known. Because this thin strip would normally be included in the right-of-way (and held so many interesting plants found only there), it is included. Additionally, the severe steepness of the banks in several places along the trail required these areas to be viewed from above and below for safety and to reduce disturbance.

When both observers were surveying, each took a side of the trail, recording notes and calling the other over to observe unusual or questionable species. We often switched sides during a section. Where just one of us surveyed, and the trip was one-way, the surveyer walked slowly and meandered from side to side; if walked round-trip, the survey was done up one side and down the other. Plants were collected only when necessary for later identification and for county records by permit from the State Park Superintendent. Herbarium specimens collected were sent to the University of Michigan Herbarium; collection numbers for voucher specimens follow the species annotation on the plant list in this paper.

Trail segments

1. *Eisenhower Road to Morley*: Trail right-of-way is open for a short distance north of Eisenhower but is quickly closed in to Washington Road by oak and aspen. Trail opens again at the Washington Road crossing then becoming wooded but more open than the previous half-mile. Numerous *Quercus coccinea* (Scarlet oak) and *Q. velutina* (Black Oak) line the route, with some *Quercus macrocarpa* (Bur Oak) just north and south of the Little Muskegon River Bridge. At Morley the trail opens up to heavily disturbed city park, old rail siding, and road crossings. Except at the crossings, bordering land is wooded to the east along Northland Drive and wooded and farmland on the west. Northland Drive parallels the trail on the east along this segment.

2. *Morley to 4 Mile Road*: From Morley to 2 Mile Road, the trail is heavily covered with bordering shrubbery of *Lonicera tatarica* (Tartarian Honeysuckle), *Viburnum* spp., and various *Prunus* spp. Several small wet areas are near trail within the right-of-way. From north of 3 Mile to 4 Mile Road, the trail is heavily wooded and closed in. There are numerous steep banks and bottomland wet

areas. Bordering lands are interrupted by several residential properties and open crossings. Otherwise, the vegetation forms a mix of continuous shrub border, woodland and stream, abandoned fields in succession, or current farming operations.

3. *Four Mile Road to 7 Mile Road*: A variety of small openings and field-like areas is present, often closed in by heavy shrubbery and overhanging trees. Bordering land is mostly agricultural on one or both sides, with several farm equipment rights-of-way crossing the trail. A residential area bordering on the east side of the trail about 0.33 mile south of 5 Mile Road has several cultivar plants that enter onto the right-of-way of the trail: one large stand of *Polygonum cuspidatum* (Japanese Knotweed) and an extensive patch of *Vinca minor* (Periwinkle) in particular. Along the curve south of 4 Mile Road, a stream parallels the west side of the trail creating a thin strip of wetland at the base of the bank to the fence. Several small wet depressions that dry up in late summer are found between 5 and 6 Mile Roads.

4. *Seven Mile Road to Johnson Road*: This section parallels 185th Avenue through Stanwood (Front Street in town) and is for the most part dry, except for one damp area, about 0.15 mile north of 8 Mile Road, which has the county's only known example of *Equisetum variegatum* (Horsetail). Southwest of the corner of Jefferson and Front streets in Stanwood is a rich assortment of weedy forbs, several of which are county records. One of only three *Humulus lupulus* (Common Hop) plants known in the county occurs on the south side of a small stream crossing just south of the above location. Ditching along the trail presents numerous damp habitats mostly filled with *Cornus foemina* (Gray Dogwood).

5. *Johnson Road to Arnold Road*: For the most part, this stretch is dry upland along the trail proper, as the rail grade is elevated well above the surrounding right-of-way, sometimes by 30 to 50 feet. The right-of-way is mostly woodland of maple and aspen, with some oak. Several creeks cross beneath the rail bed and a number of small wetlands, ephemeral water in depressions, stream edge, and one beaver pond are all partly within the right-of-way. Land that is even with the rail bed is dry where open, and damp to dry woods where tree-covered. Two unique habitats to the trail are found in this section. One occurs in a damp section about 0.125 mile long about 0.375 mile north of Angling Road on the broad curve: a habitat of mesic plants in the trail and fringing ditch including *Cyperus rivularis* and *Rhynchospora* spp., among others. The second is a spent beaver pond whose stream now flows freely. Most of the aquatics for this stretch are found here at the bottom of the bank along the fence line.

6. *Arnold Road to North End Park*: This section is very dry, passing through open shrubby edge, bordering oak woodlands, and agricultural fields from Arnold Road to New Millpond Road. A large stand of *Corylus americana* (Hazelnut) is found along this stretch. From New Millpond Road to the south end of Big Rapids at M-20, the trail is dry and open with only a small amount of woodland sparsely treed with oak and cherry. As the trail passes through Big Rapids, from M-20 to North End Park, plants attuned to disturbance heavily influence the trail and there are many misplaced cultivars. Pavement of the trail begins just north of M-20, thus eliminating the trail-habitat zone (see below)

from there to Meceola Road. Ryan and Higginson Creek crossings provide the only wetland habitat on this stretch.

7. *North End Park to 19 Mile Road*: The trail is mostly wooded on the east by *Populus tremuloides*, *P. grandidentata*, *Acer* spp. and *Quercus* spp. The west side is similar but more open, with some field influence, particularly near North End Park. Several residences abut the trail on the west. Bordering land is wooded or field on both sides. After Spruce Road, the right-of-way is an open-woods border of *Acer* spp., *Prunus* spp., and *Ulmus americana* on both sides with much *Lonicera tatarica*; some of the woodlots extend into the bordering lands that are fallow fields.

8. *19 Mile Road to 20 Mile Road*: Open field on both sides with a few small copses of woodland. Several commercial sites, particularly two cement plants, border the south end on each side. Bordering land is otherwise agricultural, cultivated, or abandoned.

9. *20 Mile Road to Paris Park*: Except for a section about 0.375 mile long north of 20 Mile Road and in Paris, this section is wet with springy seeps, hemlock-cedar swamp, bordering wet ditches, and small streams. Open at both ends, this section is otherwise shaded by overhanging and fringing trees much of the length, or with open swamp-like vegetation of *Salix*, *Thuja*, and *Typha*. Bordering lands are marshy and wet on the east with open commercial land and fields at the southern end. A unique, steep, springy hillside runs along much of the west side in the central area. From the south end of Paris to Paris Park, the trail is commercial-residential with much disturbance from mowing, gardening, or localized soil disturbance, and heavily overgrown with weedy and viney growth; a number of garden escapes are mixed into this.

10. *Paris Park to Meceola Road*: Northward from the entrance to Paris Park, the trail is open and heavily disturbed by foot traffic and mowing. The trail is shaded by young aspens and oak not far beyond the park headquarters buildings to near 207th Avenue, where the trail opens and becomes shrubby and grassy to 23 Mile Road. From 23 Mile Road to Meceola Road (the end of the trail in Mecosta County) is open country with only a few shrubs and trees, heavily dominated by grasses.

The study also divided the trail into four habitat zones from the center of the trail to the right-of-way and two specialized zones comprised of any highly disturbed areas and rail sidings (5 and 6 below).

Habitat Zones

1. *Trail*. The trail center and former tracks and ties area: this is paved from Big Rapids to Reed City, eliminating all plants in segments 6–10 (from Big Rapids north to Meceola Road).

2. *Mown edge*. The mown edge of the trail extends from outside the rail bed to the end of mowing, about 4 to 6 feet wide on each side. The soil of the trail and the mown areas is gravelly, comprised of general gravel and/or crushed limestone or cinders mixed with the other two. This soil often extends a bit farther into the edge zone (below) or may extend some distance over and down the

steep banks onto the right-of-way. The banks may be nearly devoid of significant ground-cover vegetation.

3. *Edge*. This is an ill-defined but recognizable area from the edge of the mow line to the well-established right-of-way; width varies from none to about 5–8 feet wide depending on past disturbances. Edge is most prominent along wooded areas and least obvious in fields. The gravelly rail-bed soil fades out and more established humus and dirt based soil begins.

4. *Right-of-way* (rt-way in plant list). This is the area between the edge habitat and the fence of the railroad/park property; it varies from none (in towns) to about 40 feet wide on each side. This is the least-disturbed habitat and is largely made up of established humus-rich soils derived from woods or field vegetation and the underlying soil association. The right-of-way also varies from dry sandy openings to rich woodlands, wet depressions, streambeds, beaver ponds, cedar swamp, and marsh. This zone is often heavily wooded to the edge of the trail bed. The right-of-way may contain extensive areas of steep gravelly rail bed bank soil with little humus build-up or understory vegetation.

5. *Highly disturbed areas*. Any recently or regularly disturbed area such as recent dirt dumps, grading at road crossings, culvert work, signage, work around the recently installed pit-toilets in Big Rapids and Morley, and similar disturbances.

6. *Rail yards and sidings*. These are areas heavily filled with cinders as sidings in Big Rapids, Stanwood, and Morley. They are very dry, grassy habitats, often with old rail ties still in place. Only two plant species were found associated specifically with this habitat, *Selaginella rupestris* and *Euphorbia cyparissias.*

Soils

The White Pine Trail State Park crosses five of the eight major soil types in the county. Approximately half of the trail passes over the Mecosta Association, which is comprised of well-drained sandy outwash deposits on glacial till—essentially the geologic floodplain of the Muskegon and Little Muskegon Rivers. The other four associations are spottily distributed along the trail south of 12 Mile Road. No attempt was made to correlate plant diversity to the soil types. These soil types are only in the right-of-way of the trail, the rail bed being composed entirely of various fills. The dominant soil type for the length of the trail is the gravel railroad bed that comprises the soil for the plants growing in the trail, mow, and edge habitat zones described earlier. The right-of-way zone is also influenced by the rail bed gravel soil in areas of steep banks along the trail where valleys were filled with gravel. On the valley-fill banks (as high as 40 plus feet) there is sparse ground cover beneath the trees above, yet an equally shaded area on the right-of-way at the bottom of the embankments is very lush. Except for humus-rich organic soils in ditches, a few swampy areas, low depressions and the marsh between 20 Mile Road and Paris (Trail segment 9), the soil along the trail is porous and drains rapidly. In mid-summer, many of the herbaceous plants showed definite signs of drought stress.

County Soil Types crossed by the White Pine Trail (WPT). (Distances measured by map miles northward from the south county line).

1. Perrington-Coloma-Ithaca Association. Miles approximately 5–7 and 10.5–11.25: "Nearly level to steep, well-drained, somewhat excessively drained, and somewhat poorly-drained, loamy and sandy soils that formed in glacial till or outwash deposits."
2. Coloma Association. Miles 7–8 and 9–10¾: "Nearly level to steep, somewhat excessively drained, sandy soils that formed in glacial till or outwash deposits."
3. Remus-Spinks-Meta Association. Miles approximately 3–4: "Nearly level to rolling, well-drained, loamy and sandy soils that formed in glacial till."
4. Mecosta Association. Washington Road to Little Muskegon River, Mile 12 to Meceola Road: "Nearly level to gently rolling, somewhat excessively drained, sandy soils that formed in outwash deposits or glacial till."
5. Coloma-Covert-Thetford Association. Eisenhower-Washington, Little Muskegon River to 2 Mile Road and miles 4–5: "Nearly level to rolling, somewhat excessively-drained, moderately well-drained, and somewhat poorly drained, sandy soils that formed in outwash deposits or glacial till" (USDA 1981).

RESULTS

The study of the White Pine Trail State Park through Mecosta County found 491 species of vascular plants in 96 families and 278 genera within the right-of-way. Lichens, liverworts, and mosses were not surveyed. Only one species, Prairie Smoke *Geum triflorum*, appears as Threatened on the Michigan Natural Features Inventory/DNR list of Endangered, Threatened, and Special Concern Species (MNFI 1999). One state record plant, *Rhamnus purshiana*, was found.

Nearly 30 percent (146 species or 29.7%) of the total species are considered to be non-native Eurasian or South American introductions or adventive from the western or southern United States. Here, the authors have followed Voss' (1972, 1985, 1996) assessment of foreign-acquired weeds. Included in this list are several Michigan natives that have become weedy in nature since the opening of the forests: *Polygonum aviculare*, *Chenopodium album*, *Portulaca oleracea*, *Clinopodium vulgare*, *Galium aparine*, and *Achillea millefolium.* Though they have North American as well as Eurasian origins, they are treated as non-native (Fogg 1945; USDA 1971; Mack 1991 and others). *Urtica dioica* is treated as a native (Voss 1985).

Of the 147 foreign species, 20 appear in the trail zone, with *Echinochloa crusgalli* (one plant) being the only species confined to the trail bed. Thirty-four species appear in the mow zone, with *Alyssum alyssoides* (common to abundant) and *Salsola kali* (few) confined to this zone. In the edge zone, there were 98 species with 32 of these species found only in this zone. The right-of-way (rt-way) zone held 77 species with 37 found only there. Nine species were found in the highly disturbed areas, and four were found only there. This is summarized in Table 1. All ten species representing the Caryophyllaceae are of foreign origin, as are 80% (12 of 15) of the Brassicaceae, and 83% (10 of 12) of the Polygonaceae.

There are problems in interpreting abundance. Because of routine mowing during the summer, it is difficult to determine fully the abundance of some of the

TABLE 1.

A. Summary of alien species: Species per growth type in each habitat zone.

Growth type/ # of species	Trail	Mow	Edge	Right-of-way	Disturbed areas
Annual 43	11	11	31	8	7
Biennial 15	3	8	15	10	0
Perennial 89	6	15	59	57	2

B. Summary of alien species: Species number in each habitat zone. Numbers in parentheses are species confined to that zone.

Trail	Mow	Edge	Right-of-way	Disturbed areas	Total
20 (1)	34 (2)	98 (32)	77 (37)	9 (4)	146 (78)

most prolific invasive species along the length of the trail in the mowed zone. Creeping, early spring, and species growing low to the ground are accurately indicated. These include *Polygonum aviculare*, *P. scandens*, *Alyssum alyssoides*, the creeping *Euphorbia* spp., *Plantago* spp., and *Verbena bracteata*. Those that grow upright and are mowed are more difficult to determine. Such species as both *Melilotus*, *Daucus carota*, *Euphorbia esula*, *Ambrosia artemisiifolia*, *Centaurea maculosa*, *Cichorium intybus*, *Chrysanthemum leucanthemum*, and other tall species in the mowed zone are most often found heavily stunted and never reach their full height as they do in the edge and right-of-way zones, along roadsides, and in fields where they may dominate the same zone when not mowed. *Acinos arvensis*, *Berteroa incana*, *Chaenorrhinum minus*, *Chenopodium album*, *Dianthus armeria*, and *Sonchus arvensis* are all missing from the mow zone, an area compatible with their growth requirements. This is probably due to mowing rendering them unrecognizable, for they occur in the trail and edge zones. Species with large obvious basal rosettes like *Verbascum thapsus* and *Oenothera biennis* are accurately represented as they are so large as to be difficult to miss even when cut. Early spring grasses in the mowed zone, such as *Poa annua*, *P. compressa*, *P. pratensis*, *Bromus inermis*, *B. japonica*, and *B. tectorum* are also accurately represented as they are well into blooming by the time the first mowing is done. Later-flowering grasses like *Dactylis glomerata*, *Phleum pratense*, *Sporobolus cryptandrus*, and *Agropyron repens* are often lopped off too short to be recognizable; it is only the few that send up new shoots between mowings that get counted, though an educated guess can be made from growth habits. Later low- and fast-growing grasses, *Agropyron repens* (recognizable though barely flowering), *Agrostis hyemalis*, *Digitaria ischaemum*, *Eragrostis pectinacea*, and *Panicum* spp., are accurately observed as to abundance, with *A. hyemalis* able to bloom well from a very low-cut level. *Saponaria officinalis* is readily noted in spring by its early leaves but appears to die back in the mowed zone throughout the summer while blooming freely in the edge and right-of-way zones.

Plants conspicuously fewer than anticipated, or absent

Portulaca oleracea (Pusley), all *Silene* spp. (Campions), *Ranunculus acris* (Tall Buttercup), *Brassica kaber* (Charlock), *Capsella bursa-pastoris* (Shepherd's Purse), *Malva moschata* (Cheeses), *Glechoma hederacea* (Gill-over-the-ground), *Lamium amplexicaule* (Dead-nettle), *Prunella vulgaris* (Self-heal), *Senecio vulgaris* (Ragwort), *Sonchus arvensis*, and *S. oleraceus* (Sow-thistles) are in surprisingly low numbers along the trail. *Sisymbrium altissimum* (Tumble Mustard), *Trifolium aureum* (Hop clover), *Abutilon theophrasti* (Velvetleaf), *Chondrilla juncea* (Skeletonweed), *Crepis tectorum* (Hawk's-beard), and *Sonchus asper* (Sow Thistle) are absent from the trail. Most of these plants are readily found on nearby roadsides, waste areas and bordering agricultural fields. Several factors may influence this absence. Regular mowing may prevent late-season plants from growing to maturity, thus reducing their ability to reseed or reach significant height to generate enough nourishment to sustain growth for underground spreading. The trail-bed soil is calcium-rich along much of the trail, and would retard weeds preferring acidic soils. The trail bed and mow-zone soils are tightly packed, difficult to dig, and stable, no longer being regularly turned as would occur on graded roadsides and in farm fields just beyond the right-of-way. This lack of disturbance would prevent species from germinating that can lie dormant as seeds for many years. The numerous hedgerow-like stands of trees within the right-of-way reduce prevailing winds and, with fast-moving vehicles no longer using the trail, there is no vortex to draw wind-dispersed seeds along the corridor. For example, *Sonchus arvensis* lines the shoulder of the nearby Northland Drive that parallels the trail, but is seldom seen far off the edge of that road and only rarely along the trail.

We also made the general observation that up-slope trail banks (cuts through rises and hills) of natural local soil and down-slope trail banks (fills through valleys) where recent dirt fill has been added or more recently worked are well vegetated with shrubs and forbs while down-slope trail banks of railroad fill are poorly vegetated and particularly deficient of forbs. The fill soil is probably heavily influenced by slag and clinkers used in the fill (a few were found on sides of the banks, particularly in the larger fills) and lime leaching from the rail bed. Shade from overstory trees may have some influence but even here, up-slope wooded areas exhibited a lusher ground layer than similar down-slope situations.

Unique habitat of the cinder sidings

Curtis (1959) noted the uniqueness of habitats high in sulfurous coal cinders (rail sidings in trail segments 2, 4, and 6). We found these habitats to contain mostly stunted grasses, a few shrubby trees (particularly *Ulmus pumila*), and other similar plants common to dry habitats elsewhere along the trail. The two species peculiar to this habitat were *Selaginella rupestris* and *Euphorbia cyparissias*. *Ambrosia psilostachya* (Western Ragweed) was found between the rail bed and the cinder sidings, but not within the cinder soil. All three species can be found in other county soils, though none are common anywhere in the county.

Plants unique to the trail

There are no rocky outcrops of any sort in Mecosta County; therefore, the White Pine Trail affords the only surface exposure of calcium-based soils. Three calciphiles exist in the county only along the White Pine Trail: *Alliaria petiolata*, *Acinos arvensis* and *Chaenorrhinum minus*. They are present only where the majority of the soil contains limestone ballast, the presence of which was confirmed by testing with dilute hydrochloric acid. The location of several *Alliaria* plants along the trail marks the first observance of this troublesome weed in Mecosta County. *Rhamnus purshiana* (a state record plant) known only from this location is represented by only six plants on the trail. *Tradescantia ohiensis* appears south and north of Morley and in trail segment 6, with only a few plants found off the trail along Northland Drive near the Washington Road crossing at the south end of Trail section 1.

Medicinal Uses

Along the trail, 319 species (65.1%) were found to have noted medicinal value (Moorman 1986; Foster & Duke 1990; Kindscher 1992).

The heightened interest in herbal medicine seems to know no limit. Since passage of the Dietary Supplement Health Education Act by Congress in 1994, herbal medicines and use of other complementary and alternative therapies that employ botanicals have generated billions of dollars of sales. Furthermore, it has been well publicized that many medicinal plants are being extirpated without regard to the preservation of the species (Foster & Duke 1990; Bourne 2000). This led to formation of the Medicinal Plant Working Group (MPWG) of the U.S. Fish and Wildlife Service (RJK is a member), chaired by J. Lyke, USFWS plant biologist, and an overall increase in protective activity for these types of plants. Included are the recent efforts of the U.S. Forest Service, as detailed in their "National Strategy for Special Forest Products," and the USFWS-MPWG list of "Medicinal Plants Native to the U.S.: Indicators of Rarity and Threat for 205 Species," as well as the U.S. Non-Timber Forest Products (NTFP) database (http://fcae.org/ntfpl).

Having conducted the survey, we next compared our findings with the above three references and to U.S. medicinal plants noted in Foster & Duke 1990, Moerman 1986, and Kindscher 1992. The surprising result was that fully 65% of the species (319 of 491) were identified as having a documented medicinal use according to one or more of the references. An additional 57, or almost 12%, were listed in the NTFP database as having food, decorative, or other non-medicinal uses. Forty-five species of medicinal plants found along the trail were listed in Lyke's "Medicinal Plants Native to the United States: Indicators of Rarity and Threat for 205 Species." Three of those (*Artemisia ludoviciana, Asarum canadense,* and *Eupatorium perfoliatum*) are listed as state-level concerns in Michigan. Only four of these cited medicinal species were abundant along the trail (*Equisetum arvense, Equisetum hymenale, Monarda fistulosa* and *Zanthoxylum americanum*) and only a very few species were locally common or common in a single section (*Sanguinaria canadensis, Asarum canadense,*

Podophyllum peltatum as examples). Collection is not allowed along the trail (without permit), but protection of these species could prove difficult as the trail is seldom patrolled.

DISCUSSION

The plant-community structure along the length of the White Pine Trail State Park in Mecosta County consists of a wide range of successional communities from the initial bare-earth stage to nearing climax Sugar Maple-Basswood. Beckwith (1954) lists the following stages in his study of succession on abandoned farmland in Washtenaw County, Michigan:

1. Bare soil
2. Crustose lichens
3. Mosses and foliose lichens
4. Annuals and biennials (1–2 years after abandonment)
5. Grass and other perennials (3 years after abandonment)
6. Mixed herbaceous perennials (6–10 years after abandonment, predominant at 11–15 years)
7. Shrubs (6–15 years after abandonment, predominant 16–20 years)
8. Shade–intolerant trees (sown soon after last cultivation, predominant 21–25 years)
9. Mid-tolerant trees (sown soon after last cultivation, predominant at 25 years plus)
10. Shade-tolerant trees (sown soon after last cultivation, predominant at 25 years plus).

A subjective view of this process along the trail indicates general agreement with this order and time frame. Stages one, two, and three are essentially absent along the trail except in several small patches in trail sections 4–6, in bare sandy areas in the right-of-way. The annual/biennial-stage plants along the trail bed and mow zone are more likely due to opportunity rather than a true successional stage because of continual disturbance from feet, bicycles, maintenance vehicles, Amish buggy traffic, and repeated mowing. What annual/biennial stage occurs is mostly in the edge zone. This zone disappears completely due to perennial-plant encroachment in the open areas. Only in the shade and semi-shade areas does the annual/biennial stage appear to exist as a successional stage. Zimdhal (1983) points out that the composition of a plant community is dependent on "local soils, their nutrient content, water capacity, and aeration" resulting in populations that may be limited to a few isolated plants. This appears to be true along the trail, as a number of aggressively weedy species (*Capsella bursa-pastoris*, *Silene* spp., and *Sonchus* spp., for example) in nearby fields and roadsides are found in very small numbers along the trail, probably mostly dependent on soil chemistry. The roadbed soil is tightly compacted and very difficult to dig into, but appears to retain a surprisingly high water content not far below the surface. At the same time, plants in the right-of-way may be exhibiting signs of drought-stress wilting.

The perennial grass stage is the first of the stages noted by Beckwith (1954) to be truly operating within the WPT right-of-way. The alien species along the trail correspond well with the analysis of species found in the agrestal weeds present in cultivated (corn) and grain-crop (winter wheat and alfalfa) agriculture ad-

joining the trail, with ruderal weeds, and with pasture-derived community weeds as detailed in his study. At present, all but a small portion of the adjoining agricultural land bordering the trail is planted in corn and other grain. Though crops are rotated, winter wheat, pasture grasses, and alfalfa were seen only in a few fields during our 2001-season study. Meyers (1979) indicates that a continual invasion of plants occurs, with a few becoming naturalized to an area. Many of the invasive weeds and escapes from cultivation that reach an area will fail to become established, and may persist only through continual reintroduction due to human activity. Many of the agrestal and ruderal weeds have lengthy dormancy periods (often decades), and so are in prime position to begin germination and growth soon after exposure. During major disturbance, such as the removal of the tracks and ties and subsequent leveling of the trail during preparation for public use, to such small perturbations as around holes dug for signage, these seeds are unearthed and grow. These processes as detailed in Beckwith and Meyers appear to be operating now.

While it is not possible to determine the exact origin of the alien weeds along the trail, early agriculture is the most likely source of many, primarily influenced by the railroad as a means of transport. Agricultural seed contamination with alien weeds was often quite high prior to pure-seed laws (Fogg 1945; Beckwith 1954; Mack 1991). *Agrostemma githago* was often considered a favorable weed among the early corn crops, for its large seeds could be used to pad the weight of the crop in poor corn-yield years (Beckwith 1954; Holzner 1982). Not to be overlooked either, as a source of weeds, are the various early state roads, the first of which was in progress by 1863. Such roads (there were three by 1879 when the last of the railroads entered the county) were built with hand labor and draft-animal-pulled wagons and graders, much in the manner that the railroads were bedded.

In his analysis of the offerings in early seed catalogs, Mack (1991) makes a convincing case that many of our alien weeds were introduced through mail-order purchases that became popular just after the Civil War, a time when rail and improved postal services provided more rapid and reliable delivery. Many of the seeds available in these catalogs were common weeds used for pot herbs, garden vegetables, medicinals, and ornamentals, and contained a high percentage of contaminant weeds. Travelers also likely carried a number of alien seeds for sale. John Chapman, "Johnny Appleseed," for instance, was known to carry with him seeds of "mullein, motherwort, dandelion, wintergreen, pennyroyal, and mayweed and was expert in their use," along with his famous apple seeds (Pollan 2001). Darlington (1918) remarks on the 50% rate of increase in introduction of plant species between 1881 and 1904, mainly due to the increase in road construction and railroads. Additionally, many alien seeds associated with areas surrounding railroad grain elevators in Canada have been documented by Alex (1982). He also attributes many alien seed introductions to 1.) Settlers trading seeds carried with them, 2.) The spread of seeds screened from seed purification businesses sold as livestock feed, 3.) Farmers purchasing unscreened feed grain for livestock, then using the seed for planting because it was cheaper, and finally 4.) Seeds introduced by spreading green manure on fields.

Another major source of weed seeds was in the ballast used in rail cars, which

was often dumped along the way. Presently, road work where county roads cross the trail turns over dormant seeds already present or adds new weeds when dirt is dumped to maintain the roads and trail crossings. A few final and probably minor sources of weeds along the trail are: seeds in tires of the few service vehicles and mowing machines used along the trail, wildlife movement across the trail from farmland (particularly deer), horse manure from Amish farmers who use the trail as a means of avoiding the busy Northland Drive paralleling the trail, farm vehicles crossing the trail at several points from one field to another, and pedestrian and bicycle traffic along the trail that bring in seeds on shoes and tires. Amish buggy wheels and horses' hooves may carry more seeds to the trail than might be thought. A dozen weed species (*Pastinaca sativa*, *Lathyrus tuberosus*, and *Lotus corniculata*, as examples) are found on the trail only in the Amish farm area.

CONCLUSION

The White Pine Trail in Mecosta County, Michigan, passes through a wide variety of disturbed habitats as a corridor about 50–150 feet wide by approximately 25 miles long. Nearly 30% of the species found (146 of 491) are considered non-native weeds. The general habitat structure of the trail seems to be stable except where disturbed, with the most apparent spread of weedy plants appearing there. Annual weeds account for only 28% (43 of 147) of the weed species and reach their greatest concentration in the edge zone, as the calcium-rich soil of the trail and mow zones fades out and the perennials of the right-of-way do not outcompete them. The greatest concentration of species is found in the most stable habitat zones, the edge and right-of-way. Habitat structure ranges from small areas of bare soil to nearly climax woodland. Weed structure in the four vegetation zones (trail bed, mown area, edge and right-of-way) appears to follow quite closely that detailed in Beckwith (1954), except that the bare soil through annual stages are small in area or poorly represented. Many weeds of nearby agricultural and roadside sites were found either in small, scattered populations or absent. Ruderal weeds as a group are common along the trail, mow, and edge zones, though many are poorly represented. They reach their greatest abundance in the most recently disturbed areas, such as around new signage, dirt dumps, diggings, grading, etc. Perennials dominate the right-of-way in all habitats.

A wide variety of human-influenced sources is responsible for the introduction and distribution of the alien weed and weedy native species along the trail. The authors found no discernible evidence of natural arrival of these species to the trail environment, though some animal and wind distribution along the trail may occur. A general succession toward a woodland structure is apparent throughout the trail where left undisturbed and allowed to progress naturally. An unexpected 65% (319 of 491) of the species identified within the trail right-of-way have some alleged medicinal value (Foster & Duke 1990; Kindscher 1992; Moerman 1986).

DISCLAIMER

Identification of species with medicinal use should not be read as promoting actual or experimental use by individuals, who could thereby do harm to themselves or others. The listing of these species is not intended to be an herbal or medicinal guide to their use, only their presence and location along the White Pine Trail. Furthermore, the reader is advised that *no collecting of these species along the trail is allowed without a permit from the State of Michigan.*

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ANNOTATED LIST OF VASCULAR PLANTS OF THE WHITE PINE TRAIL STATE PARK, MECOSTA COUNTY, MICHIGAN

The pteridophytes follow Lellinger (1985). The gymnosperms and angiosperms follow the order used in Voss (1976, 1985, 1996), but the species are listed in alphabetical order within families. Vernacular names generally follow these authors. Bolded species are non-native to North America.

The ethnobotanical medicinal uses for the plants in the list have been determined following the authority of Foster & Duke (1990; abbreviated as FD in the list below), Kindscher (1992; K in the list below), and Moerman (1986; Mo in the list below). Specifically used species are cited. In a few exceptions, species are correlated to a simple genus citation only by the authority.

ABUNDANCE CODES

A = abundant: almost everywhere along the trail segment and generally dominating long sections or large areas.

C = common: easily found but not dominating the trailside, often spaced between areas of the species.

La, Lc and Lu = plants that are locally abundant (dominates local area with no intervening species), locally common (thickly populating an area but with a few intervening species), or locally uncommon (in a localized area but individuals well spaced) along the trail. These plants may be in groups of singles or clusters at one point or a few points on the trail but widely separated by distance.

U = uncommon: fairly easily found but may be well spaced.

F = few: about 5–15 plants total and widely spaced along the trail.

1–5: number of single plants (or clumps of a clumping species) observed along the trail; could be more common but the few plants make exact numbers difficult to determine.

R = rare: a plant that is rare on the trail and also rare in the county overall. Any of the species above, except those marked with an R, may be common elsewhere in the county.

ADDITIONAL SYMBOLS

* = Another species in the genus is used medicinally, but not this species. The authority, however, notes the genus.

FD, K, and Mo indicate the authority describing plants having medicinal uses (see Literature Cited).

List summary: 491 species in 96 families and 278 genera. Non-native species, 146 (29.7%). Species with medicinal value as noted in literature, 319 (65.1%).

In the listing below, the data are given in the following sequence: Latin name and author; common name; medicinal information author, if any; number of trail segments where the species was found; range of abundance in the trail segments where the species was found; habitat zone(s); habitat and soil where the species occurred; Ross & Krueger *collection numbers*—all voucher specimens were sent to MICH.

PTERIDOPHYTES

SELAGINELLACEAE (Spike-moss Family)

Selaginella rupestris (L.) Link; Northern Spike-moss. 1, R. Rt-way; Big Rapids between Baldwin-Madison Streets; cindery siding soil.

EQUISETACEAE (Horsetail Family)

Equisetum arvense L.; Common Horsetail (FD, K, Mo). 10, Lu-A. Mow, edge; damp and dry soils.

Equisetum hyemale L.; Scouring Rush (FD, K, Mo). 9, Lc-C. Mow, edge; damp to dry rail bed soil.

Equisetum laevigatum A. Braun; Smooth Scouring-rush. 4, F-Lc. Edge; wet soil.

Equisetum palustre L.; Swamp Horsetail. 2, Lc. Rt-way; wet depressions.

Equisetum sylvaticum L.; Woodland Horsetail (FD, Mo). 1, La. Rt-way; wet ditches south of Paris.

Equisetum variegatum Schleich. ex Usteri; Variegated Scouring-rush. (FD, Mo). 1, Lu. Edge; wet soil. *2027*

OSMUNDACEAE (Royal Fern Family)

Osmunda cinnamomea L.; Cinnamon Fern (Mo). 6, Lu-C. Rt-way; rich, damp, shaded woods.

Osmunda claytoniana L.; Interrupted Fern. 4, Lu-C. Rt-way; rich, damp, shaded woods.

Osmunda regalis L.; Royal Fern (Mo). 3, Lu-C. Rt-way; rich, damp, shaded woods.

PTERIDACEAE (Maidenhair Fern Family)

Adiantum pedatum L.; Maidenhair Fern (FD, Mo). 2, Lu-F. Rt-way; low, damp, shaded soil.

DENNSTAEDTIACEAE (Bracken Family)

Pteridium aquilinum (L.) Kuhn; Bracken Fern (FD, Mo). 9, F-A. Edge, rt-way; dry semi-shaded soils.

THELYPTERIDACEAE (Marsh Fern Family)

Thelypteris noveboracensis (L.) Nieuwl.; New York Fern . 2, Lu. Rt-way; rich damp woodland soils.

DRYOPTERIDACEAE (Wood Fern Family)

Athyrium filix-femina (L.) Schott; Lady Fern (FD, Mo). 2, C. Rt-way; damp well-shaded woods.

Cystopteris bulbifera (L.) Bernh.; Bladder Fern. 1, C. Rt-way; damp shaded cedar soil.

Matteuccia struthiopteris (L.) Todaro; Ostrich Fern. 1, one large clump. Edge; shaded under shrubbery.

Onoclea sensibilis L.; Sensitive Fern (Mo). 7, Lc-C. Edge, rt-way; damp shaded woods.

Polystichum acrostichoides (Michx.) Schott; Christmas Fern (FD, Mo). 1, Three plants. Rt-way; damp rich woods.

GYMNOSPERMS

PINACEAE (Pine Family)

Abies balsamea (L.) Miller; Balsam Fir (FD, Mo). 1, One tree. Rt-way.

Picea pungens Englem.; Colorado Blue Spruce (Mo). 2, One-F. Rt-way; dry ground. Western NA.

Pinus resinosa Aiton; Red Pine (FD, Mo). 4, F. Rt-way; dry sandy soils.
Pinus strobus L.; White Pine (FD, Mo). 6, One-U. Rt-way; dry sandy soils.
Pinus sylvestris **L.**; Scot's Pine. 4, F. Rt-way; dry sandy soils. Europe.
Tsuga canadensis (L.) Carr.; Eastern Hemlock (FD, Mo). 2 Lc-F. Rt-way; wet and damp soils.

CUPRESSACEAE (Cypress Family)
Juniperus communis L.; Ground Juniper (FD, K, Mo). 1, U. Rt-way; dry open area in field.
Juniperus virginiana L.; Eastern Red Cedar (FD, K, Mo). 5, One-Lu. Rt-way; dry partially shaded areas.
Thuja occidentalis L.; Northern White Cedar (FD, Mo). 3, F. Edge, rt-way; ornamental mostly, and natural in cedar swamp south of Paris.

ANGIOSPERMS
MONOCOTS

TYPHACEAE (Cat-tail Family)
Typha latifolia L.; Common Cat-tail (FD, K, Mo). 6, Two-C. Edge rt-way; wet depressions.
Typha angustifolia L.; Narrow-leaved Cat-tail (FD, K, Mo). 2, F-C. Edge rt-way; wet depressions.

SPARGANIACEAE (Bur-reed Family)
Sparganium eurycarpum Engelm; Great Bur-reed (Mo). 1, La. Rt-way; well-shaded wet ditch south of Paris.

ALISMATACEAE (Water Plantain Family)
Sagittaria latifolia Willd.; Duck Potato (FD, Mo). 1, Lc. Rt-way; wet ditches south of Paris.

HYDROCHARITACEAE (Frog's-bit Family)
Vallisneria americana Michx.; Wild Celery. 1 Lu. Rt-way; wet ditches south of Paris.

POACEAE (Grass Family)
Agropyron repens (L.) Beauv.; Quack Grass (FD, Mo). 10, Lc-A. Mow, edge; dry open soil. Eurasia.
Agrostis hyemalis (Walter) BSP.; Tickle Grass. 10, Lc-C. Trail, mow; open dry soil.
Andropogon gerardii Vitman; Big Bluestem (FD, K, Mo). 2, Two-U. Edge, rt-way; dry gravelly soil.
Brachyelytrum erectum (Roth) P. Beauv. 1, Lu. Rt-way; shaded woods edge.
Bromus pubescens Willd.; Canada Brome. 1, Three plants; Rt-way; shady woods on bank.
Bromus inermis **Leysser**; Smooth Brome. 10, A. Edge, rt-way; open gravelly soil. Europe.
Bromus japonicus Murray; Japanese Brome. 9, U-C. Edge; open gravelly soil. Eurasia.
Bromus mollis **L.**; Soft Chess. 1, Lu. Highly disturbed area, in dry sand along a crossing driveway. Europe. *2020*
Bromus tectorum **L.**; Downy Chess (FD, Mo). 6, F-C. Edge, rt-way; open gravelly soil. Europe. *2026*
Calamagrostis canadensis (Michx.) Beauv.; Reedgrass. 2, Lu-Lc. Rt-way; wet depressions.
Dactylis glomerata **L.**; Orchard Grass. 7, U-C. Edge, rt-way; dry open ground. Eurasia.
Digitaria ischaemum **(Schreber) Muhl.**; Crab Grass. 5, C-A. Trail, mow; dry, gravelly, open areas. Eurasia.
Echinochloa crusgalli **(L.) Beauv.**; Barnyard Grass (Mo). 1, One depauperate plant. Trail. Old World.
Echinochloa muricata (Beauv.) Fern; Barnyard Grass. 1, Lu. Disturbed area around signage.
Elymus canadensis L.; Canada Wild Rye (Mo). 2. U. Edge; open to semi-shade.
Eragrostis pectinacea (Michx.) Nees. 6, Two-C. Trail, mow; dry disturbed soil.
Glyceria canadensis (Michx.) Trin.; Grass (Mo). 1, Lc. Rt-way; wet open depressions.
Glyceria striata (Lam.) A. Hitchc.; Fowl Manna Grass (Mo). 1, U. Rt-way; semi-shade, wet areas. *2019*
Hystrix patula Moench; Bottlebrush Grass. 3, One-U. Edge; damp shaded soil.
Lolium perenne **L.**; Ryegrass. 7, Lc-C. Edge; as mix for erosion control.
Oryzopsis asperifolia Michx.; Rice-grass. 1, One plant. Edge; shaded rich woodland soil.
Panicum depauperatum Muhl. Panic Grass. 3, F-U. Edge; dry, gravelly, open areas.

Panicum latifolium L.; Panic Grass. 2, Lu-F. Edge; shaded woods.
Panicum linearifolium Britton; Panic Grass. 1, Lu. Edge; dry open areas. 2018
***Phalaris arundinacea* L.**; Reed Canary Grass. 3, Lc-U. Rt-way; damp-wet open areas. Eurasia.
***Phleum pratense* L.**; Timothy. 7, F-C. Mow, edge, rt-way; dry open areas. Eurasia.
Poa annua L.; Annual Bluegrass. 3, F. Trail, mow; open gravelly soils.
***Poa compressa* L.**; Canada Bluegrass. 10, Lc-A. Trail, mow; open gravelly soils. Europe.
***Poa pratensis* L.**; Kentucky Bluegrass. 8, U-A. Trail, mow; open gravelly soils. Europe.
***Secale cereale* L.**; Annual Rye. 2, Three plants-U. Mow, edge; as a soil stabilizer. Escape from cultivation.
***Setaria viridis* (L.) Beauv.**; Foxtail Grass. 10, Two-A. Trail, mow, edge, disturbed areas; dry soil. Eurasia.
Sporobolus cryptandrus (Torrey) Gray; Dropseed (Mo). 8, La-A. Trail, mow; dry gravelly soil.

CYPERACEAE (Sedge Family)
Carex albursina Sheldon. (Mo*). 1, One plant. Edge; shaded gravelly soil.
Carex arctata Boott. 1, Two plants. Edge; gravelly soil.
Carex argyrantha Tuckerman. 1, Three plants. Edge; dry, open soil among low grasses.
Carex bebbii (Bailey) Fern. 1, F. Rt-way; wet ditch.
Carex brevior (Dewey). Mack. (FD, Mo). 1, F. Rt-way; damp railbed, several clumps north of Angling Road.
Carex cristatella Britton. 2, One plant each. Rt-way; wet woods. *2048*
Carex flava L. 1, Lc, Rt-way; damp soil.
Carex foenea Willd. 1, Lu. Rt-way; dry shaded grassy area north of Baldwin St., Big Rapids. 1196
Carex granularis Willd. 5, Two-F. Edge; damp gravelly soil.
Carex hystericina Willd. 3, Lu-Lc. Rt-way; low, shady, damp ground.
Carex interior Bailey. 4, F-U. Edge, rt-way; damp ground.
Carex intumescens Rudge. 2, One plant-Lu. Rt-way; edges of wet ground.
Carex lupulina Willd. 2, Three plants-La. Rt-way; shady damp ground.
Carex muhlenbergii Willd. 1, One plant. Edge; just off tarmac between Colburn and Taft St., Big Rapids. *1195*
Carex pensylvanica Lam.; Pennsylvania Sedge (FD, Mo). 9, La-A. Rt-way; dry shaded woods.
Carex sprengelii Sprengel. 3, F. Edge; damp soil.
Carex stipata Willd. 3, Lu-F. Edge, rt-way; damp ground.
Carex stricta Lam. Tussock Sedge. 1, La. Rt-way; damp to wet soils.
Carex vulpinoidea Michx. (Mo). 1, Lu. Rt-way; wet ditch.
Cyperus filiculmis Vahl.; Nut-grass. 1, One plant-Lu. Edge; dry soil.
Cyperus rivularis Kunth; Nut Grass. 1, Lc. Trail; 0.375 mile north of Angling Road , damp soil in trail.
Rhynchospora sp. (not identifiable to species; immature when found, later mowed); Beak-rush. 1, Lu. Trail; 0.375 mile north of Angling Road, damp soil in trail.
Scirpus atrovirens Willd.; Black Bulrush. 5, Two-Lc. Rt-way; damp ground streams, depressions.
Scirpus cyperinus (L.); Wool-grass. 2, Lc. Rt-way; shaded and semi-shaded wet ground.
Scirpus expansus Fern.; Bulrush. 3, Lu-Lc. Rt-way; shaded and semi-shaded wet ground.
Scirpus pendulus Vahl.; Bulrush. 1, One plant. Rt-way; semi-shaded wet ground.

ARACEAE (Arum Family)
Arisaema triphyllum (L.) Schott; Jack-in-the-Pulpit (FD, K, Mo). 2 F-U. Rt-way; damp shady soil.
Calla palustris L.; Wild Calla (FD, Mo). 1, One clump-F. Rt-way; wet depressions.
Symplocarpus foetidus (L.) Nutt.; Skunk Cabbage (FD, Mo). 3, F-A. Rt-way; wet soils.

LEMNACEAE (Duckweed Family)
Lemna minor L.; Duckweed. 4, Lc-La. Rt-way; wet ditches, depressions.

COMMELINACEAE (Spiderwort Family)

Tradescantia ohiensis Raf.; Spiderwort (FD*). 3, Three plants-Lc. Edge, rt-way; dry open/semi-shade areas. 2041

JUNCACEAE (Rush Family)

Juncus articulatus L. 1, F. Edge; damp ditch-edge soil.
Juncus dudleyi Wieg. 2, Lu-Lc. Trail; damp trail middle.
Juncus effusus L.; Soft Rush (Mo). 2, Lu-F. Rt-way; damp-wet depressions.

LILIACEAE (Lily Family)

***Allium cepa* L.**; Garden Onion (FD). 1, One plant. Rt-way; escaped from cultivation.
Allium tricoccum Aiton; Wild Onion (FD, Mo). 3, Lu-U. Edge, rt-way; damp shady woods.
***Asparagus officinalis* L.**; Garden Asparagus (FD, Mo). 4, One plant-F. Edge, rt-way; dry open areas. Old World.
Erythronium americanum Ker; Trout-lily (FD, Mo). 1, One group-U. Rt-way; rich woodland soil.
***Hemerocallis fulva* (L.) L.**; Orange Day-lily (FD). 3, Lc-F. Rt-way; escaped from cultivation.
Hemerocallis lilio-asphodelus L.; Yellow Day-lily. 1, F. Rt-way; Big Rapids. Escaped from cultivation.
Lilium michiganense Farw.; Michigan Lily. 4, One plant-F. Rt-way; damp shaded soil.
Maianthemum canadense Desf.; Wild Lily-of-the-Valley (FD, Mo). 3, Lc-C. Rt-way; rich woodland soil.
Smilacina racemosa (L.) Desf.; False Spikenard (FD, K, Mo). 8, Lu-C. Rt-way; damp, rich, woodland soil.
Smilacina stellata (L.) Desf.; Starry False Solomon's Seal (K, Mo). 3, Lu-U. Edge; dry, gravelly soil.
Smilax rotundifolia L.; Greenbriar (FD, Mo). 4, One plant-F. Rt-way; shaded areas in damp soil and banks.
Smilax tamnoides L.; Greenbriar (Mo*). 2, One plant-Lu. Rt-way; shaded areas in damp soil and banks. *2022*
Trillium cernuum L.; Nodding Trillium. 1, Three plants. Rt-way; rich, well-shaded bank soil.
Trillium grandiflorum (Michx.) Salsb.; Large-flowered Trillium (Mo). 6, Lu-C. Rt-way; deeply shaded rich soil.
Uvularia grandiflora Sm.; Bellwort (FD). 1, F. Rt-way; rich woodland soils.
***Yucca filamentosa* L.**; Yucca (FD, Mo). 1, One plant. Rt-way; dry soil. Escaped from cultivation.

IRIDACEAE (Iris Family)

Iris pseudacorus L.; Yellow Flag Iris. 2, F. Rt-way; Big Rapids, Morley. Europe.
Iris versicolor L.; Blue Flag Iris (FD, K, Mo). 1, F. Rt-way; wet depressions.

ORCHIDACEAE (Orchid Family)

Cypripedium reginae Walter; Showy Lady Slipper. 1, Three plants. Rt-way; rich damp shaded soil.
***Epipactis helleborine* (L.) Crantz.** Helleborine. 1, Three plants. Rt-way; dry bank in deep shade. Europe.
***Habenaria (Platanthera) hyperborea* (L.) R. Br.**; Tall Northern Bog Orchid (Mo*). 1, Two plants. Rt-way; cedar bottom next to stream.

DICOTS

SALICACEAE (Willow Family)

***Populus alba* L.**; White Poplar (Mo). 2, Three plants-Lu. Edge, rt-way; cultivated planting. Europe. *1199*
Populus balsamifera L.; Balsam Poplar (FD, Mo). 5, One plant-U. Edge, rt-way; dry soil.
Populus deltoides Marsh.; Cottonwood (FD, K, Mo). 2, One plant-U. Edge, rt-way; damp soil.
Populus grandidentata Michx.; Bigtooth Aspen (Mo). 8, Lc-A. Edge, rt-way; dry soil.
Populus tremuloides Michx.; Quaking Aspen (FD, Mo). 9 C-A. Edge, rt-way; dry soil.

Salix bebbiana Sarg.; Beaked Willow (K*, Mo*). 4, One plant-C. Edge, rt-way; damp open ground. *2015*

Salix discolor Muhl.; Pussy Willow (Mo). 4, C. Edge, rt-way; damp soil, wet ditches.

Salix exigua Nutt.; Sandbar Willow (Mo). 1, One plant. Edge; top of high bank in gravelly soil. 2016

Salix humilis Marsh.; Upland Willow (K, M). 1, One plant. Rt-way; dry soil under oak and aspen. 1198

Salix lucida Muhl.; Shining Willow (FD, K, Mo). 2, F. Rt-way; damp soil at edge of wetlands. 1177

MYRICACEAE (Bayberry Family)

Comptonia peregrina (L.) Coulter; Sweet Fern (FD, Mo). 4, Lu-U. Rt-way; very dry sandy soil.

JUGLANDACEAE (Walnut Family)

Carya ovata (Miller) K. Koch; Shagbark Hickory (Mo). 1, Three plants. Rt-way; WPT at New Mill Pond Road southeast; dry soil.

Juglans nigra L.; Black Walnut (FD, Mo). 3, One plant-C. Rt-way; dry open soils.

BETULACEAE (Birch Family)

Alnus rugosa (Duroi) Sprengel; Tag Alder (FD, Mo). 5, One plant-F. Rt-way; stream edge at crossings.

Betula alleghaniensis Britton; Yellow Birch. 1, One plant. Rt-way; damp soil on bank.

Betula papyrifera Marsh.; Paper Birch (Mo). 6, One plant-F. Rt-way; damp soil, banks.

***Betula pendula* Roth**; European Birch. 2, One plant each. Rt-way; Washington Rd, White's Bridge. Europe. *1191*

Carpinus caroliniana Walter; Blue Beech (FD, Mo). 4, F-U. Rt-way; rich, shaded woods.

Corylus americana Walter; Hazelnut (FD, Mo). 4, Lc-U. R-way; gravelly, dry, open soil.

Ostrya virginiana (Miller) K. Koch; Ironwood (Mo). 4, One plant-F. Rt-way; rich shaded woods.

FAGACEAE (Beech Family)

Fagus grandifolia Ehrh; Beech (FD, Mo). 2, One plant-F. Rt-way; woodland areas.

Quercus alba L.; White Oak (FD, Mo). 7, F-C. Edge, rt-way; dry soils.

Quercus coccinea Muenchh.; Scarlet Oak. 5, One plant-C. Edge, rt-way; dry soils. 2002

Quercus macrocarpa Michx.; Bur-oak (Mo). 9, One plant-U. Edge, rt-way; dry soils mostly on banks.

Quercus rubra L.; Red Oak (FD, Mo). 8, F-C. Edge, rt-way; dry soils.

Quercus velutina Lam.; Black Oak (Mo). 3, One plant-U. Rt-way; dry sandy soils.

ULMACEAE (Elm Family)

Ulmus americana L.; American Elm (Mo). 10, F-A. Edge, rt-way; damp to dry areas, many dead.

***Ulmus pumila* L.**; Siberian Elm. 7, Lc-U. Edge, rt-way; most often lining trail in towns. Asia.

Ulmus rubra Muhl.; Red Elm (FD, Mo). 2, One plant-F. Rt-way; semi-shade.

MORACEAE (Mulberry Family)

***Morus alba* L.**; White Mulberry (FD, Mo). 1, Two plants. Edge; Big Rapids. China.

CANNABACEAE (Indian Hemp Family)

***Humulus lupulus* L.**; Common Hops (FD, K, Mo). 2, Three plants total. Rt-way; damp bank soil. Eastern Asia. 2073

URTICACEAE (Nettle Family)

Boehmeria cylindrica (L.) Sw.; Tall Nettle. 5, Lc-F. Rt-way; damp depressions.

Laportea canadensis (L.) Wedd.; Wood Nettle (FD, Mo). 4, Lc-U. Rt-way; stream edge and depressions.

Pilea fontana (Lunell) Rydb.; Clearweed. 1, Lc. Rt-way, damp depressions.

Pilea pumila (L.) A. Gray; Clearweed (FD, Mo). 2, La. Rt-way, damp depressions.

Urtica dioica L. Stinging Nettle (FD, Mo). 4, Lu-U. Rt-way; stream crossings. (Has a European component indistinguishable from North American species, Voss 1985.)

SANTALACEAE (Sandalwood Family)

Comandra umbellata (L.) Nutt.; Bastard Toadflax (FD, Mo). 5, F-C. Edge, rt-way; damp shaded soil.

ARISTOLOCHIACEAE (Birthwort Family)

Asarum canadense L.; Wild Ginger (FD, K, Mo). 2, Lc-U. Rt-way; damp shady soil.

POLYGONACEAE (Smartweed Family)

***Polygonum aviculare* L.**; Knotweed (Mo). 3, Four plants-Lc. Highly disturbed mostly at crossings. New and Old World

***Polygonum convolvulus* L.**; Black Bindweed. 1, Lc. Edge; semi-shade in gravelly soil. Europe.

***Polygonum cuspidatum* Sieb. & Zucc.**; Japanese Knotweed. 1, La. Rt-way; large clumps in semi-shade. Japan.

***Polygonum hydropiper* L.**; Water Pepper (FD, Mo). 1, F. Rt-way; edge of old beaver dam. Europe.

Polygonum pensylvanicum L.; Pinkweed. 1, Lc. Edge; SW corner Jefferson at Front, Stanwood.

***Polygonum persicaria* L.**; Lady's Thumb (FD, Mo). 5, One plant-F. Trail, edge; disturbed areas. Europe.

***Polygonum scandens* L.**; False Buckwheat. 5, One plant-Lc. Highly disturbed areas; dirt dumps.

***Rumex acetosella* L.**; Sheep Sorrel (FD, Mo). 7, Lu-C. Edge, rt-way; dry open areas. Eurasia.

***Rumex crispus* L.**; Curly Dock (FD, K, Mo). 6, F-U. Edge, rt-way; dry to damp open/semi shade. Europe.

***Rumex obtusifolius* L.**; Bitterdock (K, Mo). 1, F. Mow, edge; 0.25 mile south of 4 Mile Road. Europe.

Rumex orbiculatus A. Gray; Great Water Dock. 1, U. Rt-way; wet ditches south of Paris.

***Rumex patientia* L.**; Patience Dock (Mo). 1, One plant. Edge; Big Rapids at Baldwin St. at WPT southwest corner. Eurasia.

CHENOPODIACEAE (Goosefoot Family)

***Chenopodium album* L.**; Lamb's Quarters (FD, Mo). 3, One plant-F. Trail, edge; highly disturbed areas. Eurasia.

***Salsola kali* L.**; Russian Thistle. 2, One plant-F. Mow; dry ground, heavily cut. Eurasia.

AMARANTHACEAE (Amaranth Family)

Amaranthus blitoides S. Watson; Pigweed. 2, Lc-F. Rt-way; on dump of dirt in both locations.

Amaranthus retroflexus L.;.Pigweed (FD, Mo). 3, Lu-F. Highly disturbed areas.

NYCTAGINACEAE (Four-o'clock Family)

Mirabilis nyctaginea (Michx.) MacM.; Four-O'clock (FD, K, Mo). 9, Two plants-F. Mow, edge; dry open soils.

MOLLUGINACEAE (Carpetweed Family)

Mollugo verticillata L.; Carpetweed. 1, Lc. Edge; on several dirt dumps.

PORTULACACEAE (Purslane Family)

***Portulaca oleracea* L.**; Purslane, Pusley (FD, Mo). 1, One plant. Highly disturbed soil; Big Rapids. Western Asia, but also considered native.

CARYOPHYLLACEAE (Pink Family)

***Agrostemma githago* L.**; Corn Cockle (FD, Mo). 1, R. Edge; few in Paris, rare in county but increasing. Eurasia.

***Cerastium fontanum* Baumg.**; Mouse-eared Chickweed. 4, Two plants-F. Edge; dry shady soil. Eurasia.

***Dianthus armeria* L.**; Deptford Pink. 7, Lu-F. Dry trail, edge, rt-way; shade and open areas. Old World.

***Gypsophila paniculata* L.**; Baby's Breath. 2, One plant each location. Rt-way; dry soil. Central Asia to Central Europe.

***Saponaria officinalis* L.**; Soapwort (FD, Mo). 10, A. Edge, rt-way; dry open soil. Eurasia.
***Scleranthus annuus* L.**; Knawell. 2, Lc-F. Mow; highly disturbed ground. Eurasia.
***Silene dichotoma* Ehrh.**; Campion. 1, One plant. Edge; dry soil, just south of 4 Mile Road. Europe.
***Silene latifolia* Poiret**; (*Silene pratensis* of older works); White Campion. 9, Lc-C. Edge, rt-way; open field soil. Old World.
***Silene vulgaris* (Moench) Garcke**; Bladder Campion. 6, One plant-F. Mow, edge; open gravelly soil. Eurasia. *2042*
***Stellaria graminea* L.**; Chickweed. 1, Two plants. Rt-way; dry semi-shaded soil. Europe.
***Stellaria media* (L.) Vill.**; Chickweed (FD, Mo). 6, Lu-F. Edge, rt-way; gravelly and field soil. Eurasia.

RANUNCULACEAE (Buttercup Family)

Actaea pachypoda Ell.; Doll's Eyes (FD, Mo). 4, One plant -F. Edge, rt-way; damp shaded soil.
Actaea rubra (Aiton) Willd.; Baneberry (FD, K, Mo). 1, F. Edge; damp shaded soil.
Anemone canadensis L.; Canada Anemone (FD, K, Mo). 5, Lc-U. Edge, rt-way; damp shady areas.
Anemone cylindrica A. Gray; Thimbleweed (Mo). 7, One plant-U. Edge, rt-way; shady areas.
Anemone quinquefolia L.; Wood Anemone (FD)*. 6, One plant-U. Edge; dry shaded soil.
Aquilegia canadensis L.; Wild Columbine (FD, K, Mo). 6, Lc-U. Edge, rt-way; shady damp to dry soil.
Caltha palustris L.; Marsh Marigold (FD, Mo). 4, Lu-A. Rt-way; mostly at stream crossings.
Clematis virginiana L.; Virgin's Bower (FD, Mo). 10, F-C. Edge, rt-way; damp shady woods edge.
Hepatica acutiloba DC.; Hepatica (FD, Mo). 1, Lu. Edge; damp deep shady woods.
Isopyrum biternatum (Raf.) T. & G.; False Rue Anemone. 2, F-C. Rt-way; damp shaded soil.
Ranunculus abortivus L.; Small Flowered Buttercup (Mo). 1, U. Edge, rt-way; damp shaded areas.
***Ranunculus acris* L.**; Tall Buttercup (FD, Mo). 2, U-C. Edge, rt-way; damp to dry open areas. Europe
Ranunculus hispidus Michx.; Swamp Buttercup. 4, Lu-C. Rt-way; wet depressions.
Ranunculus sceleratus L.; Cursed Crowfoot (Mo). 1, R, only known location in county. Rt-way; several in one wet depression north of Washington Road. 1190
Thalictrum dasycarpum Fisch. & Avé-Lall.; Purple Meadow Rue (Mo). 7, One plant-U. Edge, rt-way; rich, damp, woodland soils.
Thalictrum dioicum Fisch. & Avé-Lall.; Meadow Rue (Mo). 6, One plant-U. Edge, rt-way; rich, damp, woodland soils.

BERBERIDACEAE (Barberry Family)

***Berberis thunbergii* DC.**; Japanese Barberry. 1, One plant. Rt-way; damp shaded soil. Asia. 1175
Caulophyllum thalictroides (L.) Michx.; Blue Cohosh (FD, Mo). 2, One plant-F. Rt-way; rich, damp, shaded soil.
Podophyllum peltatum L.; May Apple (FD, Mo). 7, La-C. Rt-way; woodland soils.

MENISPERMACEAE (Moonseed Family)

Menispemum canadense L.; Moonseed (FD, Mo). 1, La, two locations in one section. Rt-way; vining through shrubbery. 2053

LAURACEAE (Laurel Family)

Sassafras albidum (Nutt.) Nees; Sassafras (FD, Mo). 5, Lc-F. Edge, -rt-way; semi-shaded areas.

PAPAVERACEAE (Poppy Family)

***Chelidonium majus* L.**; Celandine (FD, Mo). 2, F. Edge; damp shaded soil. Eurasia.
Sanguinaria canadensis L.; Bloodroot (FD, Mo). 6, Lc-C. Rt-way; damp, rich, shaded woodland soil.

FUMARIACEAE (Fumitory Family)

Dicentra cucullaria (L.) Bernh.; Dutchman's Breeches (FD, Mo). 1, F. Rt-way; rich shaded soil.

CAPPARACEAE (Caper Family)

***Polanisia dodecandra* (L.) DC.**; Clammy-weed (K, as a buffalo attractant; Mo, as *Cleome*). 1, Lu. Edge; dry, gravelly soil in semi-shade. Adventive from western US.

BRASSICACEAE (Mustard Family)

***Alliaria petiolata* (Bieb.) Cavara & Grande**; Garlic Mustard. 2, One plant-F. Edge, rt-way; shaded gravelly soil. Europe and Asia. 1186

***Alyssum alyssoides* (L.) L.**; Pale Alyssum. 10, F-A. Mow; dry open, partially shaded soil. Europe-Asia Minor.

Arabidopsis thaliana (L.) heynh.; Mouse-ear Cress. 2, One to five plants. Edge; dry sandy and disturbed soil. *1197*

Arabis glabra (L.) Bernh.; Tower Mustard (FD, Mo). 4, One plant-F. Rt-way; dry partial shade soil.

***Barbarea vulgaris* R. Br.**; Yellow Rocket (FD, Mo). 9, One plant-C. Edge, rt-way; dry open soil. Eurasia.

***Berteroa incana* (L.) DC.**; Hoary Alyssum. 10, U-C. Trail, edge, rt-way; dry soil. Europe.

***Brassica kaber* (DC) Wheeler**; Charlock (FD, Mo). 2, One plant-F. Edge; open disturbed soil. Mediterranean.

***Camelina microcarpa* DC.**; False Flax. 1, One plant. Edge; SW corner Jefferson at Front, Stanwood. Eurasia. 2025

***Capsella bursa-pastoris* (L.) Medikus**; Shepherd's Purse (FD, Mo). 2, Two plants-F. Edge; dry disturbed soil. Eurasia.

Dentaria diphylla Michx.; Two-leafed Toothwort (FD, Mo). 1, U. Rt-way; rich, damp, shaded soil.

***Hesperis matronalis* L.**; Dame's Rocket. 4, Lc-U. Edge, rt-way; damp shaded soil. Europe.

***Lepidium campestre* (L.) R. Br.**; Pepper-grass. 9, F-C. Trail, mow, edge; dry gravelly soil. Eurasia.

Lepidium virginicum L.; Pepper-grass (FD, Mo). 1, Lu. Edge; SW corner Jefferson at Front, Stanwood. 2024

***Nasturtium officinale* R. Br.**; Watercress (FD, Mo). 2, F-A. Rt-way; streams and ditches. Old World.

***Thlaspi arvense* L.**; Penny Cress (Mo). 1, F. Edge; SW corner Jefferson at Front, Stanwood. Eurasia.

CRASSULACEAE (Orpine Family)

***Sedum album* L.**; Stonecrop. 1, Three plants. Edge; in weeds at trail side in Paris. Old World.

***Sedum spurium* Bieb.**; Stonecrop. 1, Five plants. Edge; North End Park at WPT junction. Caucasus.

***Sedum telephium* L.**; Live-forever (Mo). 1, Two plants. Edge; Big Rapids between Baldwin-Madison Streets. Eurasia.

SAXIFRAGACEAE (Saxifrage Family)

Mitella diphylla L.; Two-leafed Miterwort (Mo). 1, U. Rt-way; deeply shaded damp soil.

Saxifraga pensylvanica L.; Swamp Saxifrage (Mo). 4, Two plants-C. Rt-way; marshy areas in semi-shade.

Tiarella cordifolia L.; Foamflower (FD, Mo). 1, C. Edge, rt-way; damp gravelly bank and marshy soil.

GROSSULARIACEAE (Gooseberry Family)

Ribes americanum Miller; Currant (FD, K, Mo). 7, F-C. Edge, rt-way; damp shaded soils.

Ribes cynosbati L.; Prickly Goosberry (FD, Mo). 2, Two plants-F. Rt-way; damp shaded areas.

***Ribes rubrum* (*sativum*) L.**; Red Currant. 1, Two plants. Edge; escape from cultivation in Paris. W. Europe.

HAMAMELIDACEAE (Witch-hazel Family)

Hamamelis virginiana L.; Witch Hazel (FD, Mo). 7, One plant-U. Rt-way; shady woods.

ROSACEAE (Rose Family)

Agrimonia gryposepala Wallr.; Agrimony (Mo). 3, Two plants-F. Edge, rt-way; shaded rich soil.

Amelanchier arborea (Michx. f.) Fern.; Shadbush (FD, Mo). 2, Three trees. Rt-way; semi-shade.

Amelanchier laevis Wieg.; Shadbush (FD, Mo). 3, Four trees. Rt-way; generally shaded woods.

Amelanchier sanguinea (Pursh) DC. complex, Shadbush (FD, Mo). 1, One plant. Rt-way; open field.

Amelanchier sp., (FD, K, Mo). 1, One plant. Rt-way; open field.

Crataegus spp (We made no attempt to identify these to species. Most had flowers in poor condition after several storms and a late frost at the onset of our study; a two-month drought during the summer resulted in a very paltry crop of fruits by fall; there was also poor fruiting in *Rubus, Vitis,* and *Parthenocissus*). Four species might occur, to judge from differences in leaf shape); Crabapple (FD, Mo). 8, F-C. Edge, rt-way.

Fragaria virginiana Miller; Wild Strawberry (FD, K, Mo). 8, U-A. Mow, edge; shaded areas.

Geum aleppicum Jacq.; Yellow Avens (Mo). 5, Two plants-U. Edge, rt-way; field soils.

Geum canadense Jacq.; White Avens (Mo). 5, One plant-U. Edge; shaded woodland areas.

Geum rivale L.; Swamp Avens (FD, K*, Mo). 3, Five plants-Lu. Rt-way; wet depressions.

Geum triflorum Pursh; Prairie Smoke (K, Mo). 1, Three plants. Rt-way; about 0.25 mi. north of Washington Road. Michigan Threatened.

***Malus pumila* Miller**; Apple (FD*). 7, One plant-F. Rt-way; in variety of open and shaded areas. Eurasia.

Physocarpus opulifolius (L.) Maxim.; Ninebark (FD, Mo). 3, One plant-F. Edge, rt-way; shaded shrubby areas.

Potentilla argentea L.; Silvery Cinquefoil. 1, One plant. Edge; dry gravelly soil.

***Potentilla recta* L.**; Tall Cinquefoil. 10, Three plants-U. Edge; dry gravelly soil. Europe.

Potentilla simplex Michx.; Common Cinquefoil. (FD*, Mo). 8, F-U. Edge, rt-way; shady gravelly soil.

***Prunus nigra* Aiton**; Cultivated Plum (K, Mo). 1, one cluster of trees. Rt-way; Big Rapids about 0.25 mile north of Baldwin St.

Prunus pensylvanica L. f.; Pin Cherry (Mo). 7, One plant-C. Edge, rt-way; gravelly and field soil.

Prunus serotina Ehrh.; Wild Cherry (FD, K, Mo). 10, U-A. Edge, rt-way; gravelly and field soil.

Prunus virginiana L.; Choke Cherry (FD, K, Mo). 10, F-A. Edge, rt-way; gravelly and field soil.

***Pyrus communis* L.**; Cultivated Pear. 1, One plant. Rt-way; field soil. Old World.

Rosa carolina L.; Pasture Rose. 6, F-U. Edge, rt-way; dry semi-shaded soil.

***Rosa multiflora* Murray**; Multiflora Rose. 1, one moderate-sized shrub. Rt-way. E. Asia.

***Rosa* sp.**, Cultivar Rose. 1, One plant. Rt-way; shade at road crossing overhung by shrubbery.

***Rubus* sp. (*spectabilis*?) Willd.**; Cultivar Raspberry. 1, F. Rt-way; several large flowered canes in shaded hedgerow. An often-cultivated western species. Not determinable to species for certain (Voss, pers. comm.)

Rubus allegheniensis Porter; Black Raspberry (FD, K, Mo). 8, F-C. Edge, rt-way; dry to damp semi-shaded soils.

Rubus flagellaris Willd.; Northern Dewberry (Mo). 7, F-C. Edge, rt-way; dry to damp semi-shaded soils.

Rubus hispidus L.; Swamp Dewberry (Mo). 1, U. Rt-way; open wet depression.

Rubus strigosus Michx.; Wild Red Raspberry. 9, U-C. Edge, rt-way; dry to damp semi-shaded soils.

Spirea alba Duroi; Meadowsweet (FD*, Mo). 5, Three plants-U. Rt-way; damp open ground.

FABACEAE (Pea Family)

Amphicarpaea bracteata (L.) Fern.; Hog Peanut (Mo). 4, Lc-C. Edge, rt-way; dry shaded soil.

***Coronilla varia* L.**; Crown Vetch (Mo). 2, F. Edge, rt-way; persisting after use as ground cover. Europe.

Desmodium nudiflorum (L.) DC.; Naked Flowered Tick-trefoil (FD, Mo). 2, One plant each location. Edge; deeply shaded rich soil.

***Lathyrus latifolius* L.**; Everlasting Pea. 3, La-Lc. Rt-way; persisting after use as soil stabilizer. Europe.

Lathyrus ochroleucus Hooker; Pale Vetchling (Mo). 2, Two-four plants. Rt-way; dry shaded woods-edge soil. *1185*

***Lathyrus tuberosus* L.**; Tuberous Vetchling. 1, Two plants. Rt-way; dry, grassy area. 2052

Lespedeza hirta (L.) Hornem.; Hairy Bushclover (Mo*). 1, Lu. Rt-way; dry soil south of Arnold Road.

***Lotus corniculata* L.**; Birdfoot-trefoil. 1, Lu. Rt-way; one clump in field soil. Eurasia.

Lupinus perennis L.; Wild Lupine (FD, Mo). 1, One plant. Rt-way; one plant in field soil.

***Medicago lupulina* L.**; Black Medic. 10, C-A. Trail, mow, edge; gravelly soils. Eurasia.

***Medicago sativa* L.**; Alfalfa (FD, Mo). 2, One plant-U. Edge; escape from cultivation. Europe.

***Melilotus alba* Medikus**; White Sweet-clover (Mo). 8, F-C. Trail, mow, edge; gravelly soils. Old World.

***Melilotus officinalis* (L.) Pallas**; Yellow Sweet-clover (FD, Mo). 8, Lc-C. Trail, mow, edge; gravelly soils. Old World.

***Robinia hispida* L.**; Bristly Locust (Mo). 1, one large clump. Rt-way; at Riverside Camp entry south of New Millpond Road. Native in southeastern USA.

***Robinia pseudoacacia* L.**; Black Locust (FD, Mo). 4, Lu-F. Edge, rt-way; forming moderate to large clones. Native south of Michigan. 2014

***Trifolium arvense* L.**; Rabbit-foot Clover. 2, Lu-Lc. Edge; dry gravelly soil. Eurasia.

***Trifolium pratense* L.** Red Clover (FD, Mo). 9, U-A. Mow, edge; dry gravelly soil. Europe.

***Trifolium repens* L.**; White Clover (FD, Mo). 7, F-A. Mow, edge; dry gravelly soil. Eurasia.

Vicia americana Willd.; American Vetch (Mo). 1, F. Edge, rt-way; open woodland edge.

Vicia caroliniana Walter; Pale Vetch (Mo). 3, Lc-U. Edge, rt-way; open field or woods edge.

***Vicia villosa* Roth**; Hairy Vetch (FD, Mo). 9, Lc-C. Edge, rt-way; open field. Eurasia.

OXALIDACEAE (Wood-sorrel Family)

Oxalis fontana Bunge. 1, F. Edge; damp soil.

Oxalis stricta L.; Wood-sorrel (Mo). 8, Lc-C. Mow, edge, rt-way; dry semi-shade.

GERANIACEAE (Geranium Family)

Geranium maculatum L.; Wild Geranium (FD, K, Mo). 8, F-A. Edge, rt-way; damp rich soil.

Geranium robertianum L.; Herb Robert (FD), 1, F. Rt-way; damp rich soil.

RUTACEAE (Rue Family)

Ptelea trifoliata L.;Wafer-ash (FD, Mo). 1, Lu, ten shrubs. Rt-way; about 0.5 mile south of Arnold Road.

Zanthoxylum americanum Miller; Prickly-ash (FD, K, Mo). 7, Two clumps-C. Rt-way; dry to damp soils.

EUPHORBIACEAE (Spurge Family)

Euphorbia corollata L.; Flowering Spurge (FD, K, Mo). 5, One plant-F. Edge, rt-way; dry field soil.

***Euphorbia cyparissias* L.**; Cypress Spurge. 1, One clump. Rt-way; siding between Madison and Maple Streets.

***Euphorbia esula* L.**; Leafy Spurge. 6, F-A. Edge, rt-way; open dry soil. Europe.

Euphorbia glyptosperma Engelm.; Spurge (Mo). 6, Lu- C. Highly disturbed areas, trail, mow; open gravelly soils.

Euphorbia maculata L.; Spurge (Mo). 6, One plant-C. Trail, mow, highly disturbed areas: dry gravelly soil.

Euphorbia nutans Lag.; Spurge (Mo). 7 Lc-C. Trail, mow; gravelly soil. 2074

ANACARDIACEAE (Cashew Family)

Rhus copallina L.; Dwarf Sumac (FD, Mo). 1, Three plants. Edge; dry open soil.

Rhus glabra L.; Smooth Sumac (FD, K, Mo). 4, Two plants-F. Edge, rt-way; dry open to semi-shaded areas. 2047

Rhus x pulvinata Greene; Hybrid Sumac; this hybrid is listed in Voss (1985) from the county. We found several finely hairy sumacs that appeared to be intermediate between *Rhus typhina* and *Rhus glabra*; none of them had either flowers or fruits; we used our best judgment with regard to the discussion in Voss (1985). 4. Edge, rt-way; dry open to semi-shade areas.

Rhus typhina L.; Staghorn Sumac (FD, K, Mo). 8, F-C. Edge, rt-way; dry open to semi-shaded areas.

Toxicodendron radicans (L.) Kuntze; Poison Ivy (FD, Mo). 9, Lc-C. Edge, rt-way; shaded ground.

CELASTRACEAE (Bittersweet Family)

***Celastrus scandens* L.**; Bittersweet (FD, Mo). 1, Two plants. Edge; twining through shrubbery; those found are probably cultivars.

Euonymus obovatus Nutt.; Running Strawberry-bush (Mo). 5, Lu-U. Edge, rt-way; rich well-shaded soil.

ACERACEAE (Maple Family)

Acer negundo L.; Boxelder (FD, Mo). 8, F-C. Rt-way; alone or mixed among other species.

***Acer platanoides* L.**; Norway Maple. 3, one tree to U. Rt-way; mostly near dwellings or in cities. Europe.

Acer rubrum L.; Red Maple (FD, Mo). 8, F-C. Rt-way; generally damp soils.

Acer saccharum Marsh.; Sugar Maple (FD, Mo). 10, F-C. Rt-way; individuals as well as in moderate-sized woodlots.

Acer saccharum Marsh. var. *viride* (Schmidt) E. G. Voss; Black Maple (FD, Mo). 1, Two trees. Rt-way.

BALSAMINACEAE (Touch-me-not Family)

Impatiens capensis Meerb.; Spotted Jewelweed (FD, Mo). 5, Lc-C. Rt-way; damp-wet soil, stream edges.

RHAMNACEAE (Buckthorn Family)

Ceanothus americanus L.; New Jersey Tea (FD, Mo). 1, U. Edge; dry shaded soil.

***Rhamnus purshiana* DC.**; Buckthorn (Mo). 2, Six plants total. Rt-way; among other shrubs. Western U.S. *2054*

VITACEAE (Grape Family)

Parthenocissus quinquefolia (L.) Planchon; Virginia Creeper (FD, Mo). 4, F-C. Edge, rt-way; heavily vining through many trees and shrubs and along ground.

Parthenocissus inserta (A. Kerner) Fritsch; Woodbine (FD). 8, U-C. Edge, rt-way; heavily vining through many trees and shrubs and along ground.

Vitis riparia Michx.; Riverbank Grape. 10, U-A. Edge, rt-way; damp bank soil.

TILIACEAE (Linden Family)

Tilia americana L.; Linden (FD, Mo). 10, F-C. Rt-way; damp to dry soils.

MALVACEAE (Mallow Family)

***Malva moschata* L.**; Musk Mallow (Mo). 1, Lu. Edge; several in gravelly soil. Europe.

CLUSIACEAE (St. John's-wort Family)

Hypericum ascyron L.; Giant St. John's-wort. 1, Two plants. Rt-way; wet depression.

***Hypericum perforatum* L.**; St. John's-wort (FD, Mo). 9, F-C. Edge, rt-way; dry open areas. Europe.

CISTACEAE (Rockrose Family)

Helianthemum canadense (L.) Michx.; Frostweed. 1, Lu. Rt-way; just south of Arnold Road.

VIOLACEAE (Violet Family)

***Viola arvensis* Murray**; Field Violet. 1, Lu. Edge; SW corner Jefferson at Front, Stanwood. Europe. 2023

Viola cucullata Aiton; Dog Violet (Mo). 1, U. Edge, rt-way; damp shady soil.

Viola nephrophylla Greene; Violet. 1, F. Rt-way; damp soil, mostly on logs.

Viola pubescens Aiton; Downy Yellow Violet (Mo). 2, U. Edge, rt-way; damp shady soil.

Viola rostrata Pursh Long-spurred Violet. 1, F. Edge, rt-way; damp shady soil.

ELAEAGNACEAE (Oleaster Family)

***Elaeagnus umbellata* Thunb.**; Autumn Olive. 8, F-C. Edge, rt-way; dry soils. Asia.

LYTHRACEAE (Loosestrife Family)

***Lythrum salicaria* L.**; Purple Loosestrife (FD, Mo). 2, Lu. Edge; damp-wet ditches. Eurasia.

ONAGRACEAE (Evening Primrose Family)

Circaea lutetiana L.; Enchanter's Nightshade. 3, Lu-C. Rt-way, deeply shaded damp soils.
Epilobium angustifolium L.; Fireweed (FD, Mo). 3, Lu-Lc. Rt-way; shady-open areas.
Epilobium ciliatum Raf.; American Willow-herb. 1, F. Rt-way; damp ground.
Epilobium coloratum Biehler. 1, F. Rt-way; damp ground.
Oenothera biennis L.; Evening Primrose (FD, K, Mo). 10, One plant-U. Trail, edge, rt-way; dry open areas.
Oenothera parviflora L.; Small Sundrops. 1, Lu, Rt-way; dry sandy-gravel soil; just south of 4 Mile Road.

ARALIACEAE (Ginseng Family)

Aralia nudicaulis L.; Wild Sarsaparilla (FD, K, Mo). 3, Lc-C. Rt-way; damp shady soil.
Aralia racemosa L.; Spikenard (FD, Mo). 1, Three plants. Rt-way; damp, rich, well-shaded soil.

APIACEAE (Carrot Family)

Cicuta maculata L.; Water Hemlock (FD, Mo). 2, Lu-Lc. Rt-way; damp well-shaded soil, often clumped.
***Daucus carota* L.**; Wild Carrot (FD, Mo). 9, F-C. Mow, edge; damp to dry. Old World.
Heracleum maximum Bartram; Cow Parsnip (FD, Mo). 4, Two plants-Lu. Rt-way; shaded wet depressions.
Osmorhiza sp. (prob. Clatonii (Michaux) C.B. Clarke; Sweet Cicely (FD, K, Mo). 1, One old seedless plant. Rt-way; shaded rich woodland soil.
***Pastinaca sativa* L.**; Wild Parsnip (FD, Mo). 4, One plant-C. Edge, rt-way; mostly south of Stanwood. Eurasia.
Sanicula gregaria E. Bickn.; Snakeroot (Mo). 2, One plant-F. Rt-way; damp shaded soil.

CORNACEAE (Dogwood Family)

Cornus alternifolia L. f.; Alternate-leafed Dogwood (FD*, Mo). 6, F-U. Rt-way; shady wooded soil.
Cornus amomum Miller; Silky Dogwood. 2, Three plants total. Rt-way; wet soil, in fruit.
Cornus foemina Miller; Gray Dogwood (FD*, Mo). 9, La-A. Edge, rt-way; open damp soil, forming long hedgerows.
Cornus stolonifera Michx.; Red Osier Dogwood (FD*, K, Mo). 4, One plant-C. Edge, rt-way; wet ground.

ERICACEAE (Heath Family)

Chamaedaphne calyculata (L.) Moench; Leatherleaf (Mo). 1, three shrubs. Rt-way; wet boggy soil.
Gaultheria procumbens L.; Wintergreen (FD, Mo). 1, Lu. Rt-way; shaded woodland soil.
Vaccinium angustifolium Aiton; Low Sweet Blueberry (FD, Mo). 4, Lu-Lc. Rt-way; dry semi-shade.

PRIMULACEAE (Primrose Family)

Lysimachia ciliata L.; Fringed Loosestrife. 2, Lc. Edge; damp shaded soil.
Lysimachia quadrifolia L.; Whorled Loosestrife (FD, Mo). 3, One plant-U. Edge, rt-way; damp shaded soil.

OLEACEAE (Olive Family)

Fraxinus americana L.; White Ash (FD, Mo). 8, U-A. Rt-way; woodland, edge soils.
***Syringa vulgaris* L.**; Lilac. 3, one to F clumps. Rt-way; Dry semi-shaded areas, usually near dwellings. SE Europe.

GENTIANACEAE (Gentian Family)

Gentiana andrewsii Griseb.; Closed Gentian (K, Mo). 4, Lu. Edge; damp ditches.

APOCYNACEAE (Dogbane Family)

Apocynum androsaemifolium L.; Spreading Dogbane (FD, K, Mo). 9, U-C. Edge, rt-way; damp or dry sandy soil, semi-shade.

Apocynum cannabinum L.; Hemp-dogbane (FD, K, Mo). 5, One cluster-U. Edge, rt-way; damp shady soil.

***Vinca minor* L.**; Periwinkle. 2, Lc-La. Edge, rt-way; shaded areas, ground cover. Europe.

ASCLEPIADACEAE (Milkweed Family)

Asclepias incarnata L.; Swamp Milkweed (FD, K, Mo). 1, F. Edge; gravelly soil.

Asclepias syriaca L.; Common Milkweed (FD, K, Mo). 10, F-C. Edge, rt-way; dry open areas.

Asclepias tuberosa L.; Butterfly Weed (FD, K, Mo). 3, One plant-Lu. Rt-way; damp to swampy ground.

CONVOLVULACEAE (Morning-glory Family)

Calystegia sepium (L.) R. Br.; Hedge Bindweed (FD). 3, Two plants-F. Edge; dry shaded soil.

Calystegia spithamea (L.) Pursh; Low Bindweed. 2, F. Edge; dry shaded soil.

CUSCUTACEAE (Dodder Family)

Cuscuta gronovii Schultes; Dodder. 1, La. Mow; covered mow for about 50 feet; just south of 207th Ave., 2088

POLEMONIACEAE (Phlox Family)

Phlox divaricata L.; Wild Blue Phlox. 1, F. Rt-way; rich damp woods soil.

HYDROPHYLLACEAE (Waterleaf Family)

Hydrophyllum virginianum L.; Virginia Waterleaf (FD, Mo). 5, F-A. Edge, rt-way; damp shaded soil.

BORAGINACEAE (Borage Family)

***Cynoglossum officinale* L.**; Hound's Tongue (FD, Mo). 1, Three plants. Edge; dry gravelly soil under elm. Eurasia.

Hackelia virginiana (L.) I. M. Johnston; Stickseed (Mo). 1, one small cluster. Edge; damp shady ground.

***Myosotis scorpioides* L.**; Common Forget-me-not (FD, Mo*). 2, Lu-La. Rt-way; wet ditches. Eurasia.

VERBENACEAE (Vervain Family)

Phryma leptostachya L.; Lopseed (FD, Mo). 1, Lu. Rt-way; rich, damp, woods soil.

Verbena bracteata Lag. & Rodr. Creeping Vervain (Mo). 5, Two plants-F. Mow, highly disturbed areas; gravelly soils.

Verbena hastata L.; Blue Vervain (FD, K, Mo). 2, U. Edge, rt-way; damp to dry field soils.

Verbena stricta Vent.; Hoary Vervain (Mo). 3, Two plants-Lu. Rt-way; dry open gravelly and field soil. 2061

LAMIACEAE (Mint Family)

***Acinos arvensis* (Lam.) Dandy**; Mother-of-thyme. 10, Lc-A. Trail, edge; limey gravelly soil. Europe.

***Clinopodium vulgare* L.**; Wild Basil. 6, U-C. Edge, rt-way; damp shaded soil. Europe, but also considered native.

***Glechoma hederacea* L.**; Gill-over-the ground (FD, Mo). 1, U. Edge; damp shaded ground. Eurasia

***Lamium amplexicaule* L.**; Henbit. 1, U. Edge; damp gravelly soil. Europe.

***Leonurus cardiaca* L.**; Motherwort (FD, Mo). 8, Four plants-U. Rt-way; damp soil, open and shade. Europe.

Lycopus uniflorus Michx.; Bugleweed. 3, Lc-F. Edge; damp shaded soil.

Mentha arvensis L.; Wild Mint (FD, Mo). 1, Lc. Rt-way; wet ditches south of Paris.

Monarda fistulosa L.; Bergamot (FD, K, Mo). 9, F-A. Edge, rt-way; dry open areas.

Monarda punctata L.; (FD, K, Mo). Horseweed. 2, F-U. Edge, rt-way; dry open areas.

***Nepeta cataria* L.**; Catnip (FD, Mo). 6, F-U. Edge, rt-way; damp soils. Eurasia.

***Prunella vulgaris* L.**; Self-heal (FD, Mo). 3, One-two plants each. Mow, edge; open gravelly soil. Europe, but also considered native.

SOLANACEAE (Nightshade Family)

Physalis heterophylla Nees; Ground Cherry (FD, K, Mo). 9, One plant-U. Mow, edge; dry open to semi-shaded soil.

Physalis virginiana Miller; Ground Cherry (K, Mo). 1, Lu. Edge; open field soil.

Solanum ptychanthum (*nigrum*) Dunal; Black Nightshade (K, Mo). 1, Lc. Edge, highly disturbed areas, dump piles.

***Solanum dulcamara* L.**; Deadly Nightshade (FD, Mo). 6, Lu-C. Edge, rt-way; wet ground. Eurasia.

SCROPHULARIACEAE (Snapdragon Family)

Chelone glabra L.; White Turtlehead (FD, Mo). 2, F. Edge, rt-way; damp woods soil.

***Chaenorrhinum minus* (L.) Lange**; Dwarf Snapdragon. 4, One plant-U. Trail, edge; limey gravelly soil. Europe.

Linaria canadensis (L.) Dum.-Cours.; Blue Toadflax. 3, Lu-U. Rt-way; very dry sandy openings.

***Linaria vulgaris* Miller**; Butter-and-eggs (FD, Mo). 5, Three plants-U. Edge, rt-way; dry field soil. Eurasia.

Pedicularis lanceolata Michx.; Swamp Lousewort (Mo*). 1, Three plants. Rt-way; damp shaded ground.

Penstemon hirsutus (L.) Willd.; Hairy Beardtongue (Mo*). 3, F-U. Edge, rt-way; dry open ground.

***Verbascum blattaria* L.**; Moth Mullein. 2, One to four plants. Edge; dry to damp, open, or shaded areas. Eurasia.

***Verbascum thapsus* L.**; Common Mullein (FD, Mo). 10, F-C. Mow, edge, rt-way; dry open soils. Eurasia.

Veronica anagallis-aquatica L.; Water Speedwell. 1, La. Rt-way; wet ditches south of Paris.

PLANTAGINACEAE (Plantain Family)

***Plantago lanceolata* L.**; Rib Grass (FD, Mo). 6, F-A. Trail, edge; dry disturbed soil, open and semi-shade. Eurasia.

***Plantago major* L.**; Common Plantain (FD, Mo). 7, F-C. Trail, edge; dry disturbed soil, open and semi-shade. Eurasia.

Plantago rugelii Decne.; Rugel's Plantain (Mo). 5, F-C. Trail, edge; dry disturbed soil, open and semi-shade.

RUBIACEAE (Madder Family)

Cephalanthus occidentalis L.; Buttonbush (FD, K, Mo). 1, F. Rt-way; wet depression east of Morley-Stanwood High School.

***Galium aparine* L.**; Cleavers (FD, Mo). 5, Lu.-C. Edge; damp shaded areas. Eurasia, but also considered native.

Galium asperellum Michx.; Rough Bedstraw (Mo). 4, F-C. Edge; damp shaded areas.

Galium boreale L.; Northern Bedstraw (Mo). 3, Lu-F. Edge; damp shaded areas.

Galium circaezans Michx.; (Mo). 2, Three plants-Lc. Edge; damp shaded areas.

Galium lanceolatum Torr.; Lance-leafed Bedstraw. 1, Lu. Edge; damp shaded areas.

Galium triflorum Michx.; (Mo). 3, F. Edge, rt-way; damp shaded areas.

***Galium verum* L.**; Yellow Bedstraw. 3, one cluster-Lc. Rt-way; open areas. Europe, Middle East.

Houstonia longifolia Gaertner; Long-leaf Bluet (FD*). 2, Lc-F. Rt-way; very dry shaded soil.

CAPRIFOLIACEAE (Honeysuckle Family)

Diervilla lonicera Miller; Bush-honeysuckle (FD, Mo). 9, F-C. Edge, rt-way; shaded damp soil.

Lonicera canadensis Marsh.; Canadian Honeysuckle (FD, Mo). 1, one bush. Rt-way; deep shade on steep bank.

***Lonicera tartarica* L.**; Tartarian Honeysuckle (FD). 9, F-A. Edge, rt-way; wide variety soils; form large hedges. Eurasia.

Sambucus canadensis L.; Elderberry (FD, Mo*). 5, Three plants-C. Rt-way; damp ground semi-shade.

Symphoricarpos albus (L.) S. F. Blake; Snowberry (Mo). 1, F. Edge, rt-way; damp shaded areas, probably bird spread cultivars due to proximity to houses.

Triosteum aurantiacum E. P. Bicknell; Horse Gentian (FD and Mo as *T. perfoliatum*, see Voss [1996] notes). 7, Two plants-U. Edge, rt-way; richer gravelly bank soils. 2012

Viburnum acerifolium L.; Maple-leafed Viburnum (Mo). 4, Four plants-F. Rt-way; shaded woodland soil.

Viburnum lentago L.; Nannyberry (Mo). 5, F-C. Rt-way; damp, semi-shaded hedgerows.

***Viburnum opulus* L.**; High Bush Cranberry (FD, Mo). 2, One or two plants. Rt-way; most probably an escape from cultivation.

Viburnum rafinesquianum Schultes; Arrowwood. 7, F-U. Rt-way; damp, semi-shaded hedgerows. 2011

CUCURBITACEAE (Gourd Family)

Echinocystis lobata (Michx.) T. & G.; Wild Cucumber (FD, K, Mo). 3, Two plants-U. Rt-way; entwined in shrubs.

CAMPANULACEAE (Bellflower Family)

Campanula rotundifolia L.; Harebell (Mo). 1, Lu. Rt-way; very dry soil under oak. *2064*

Lobelia siphilitica L.; Great Blue Lobelia (FD, K, Mo). 1, Lu. Edge; damp shaded ground south of Paris.

ASTERACEAE (Sunflower Family)

***Achillea millefolium* L.**; Yarrow (FD, K, Mo). 10, F-A. Edge, rt-way; dry open field soil. Europe, but also considered native.

Ambrosia artemisiifolia L.; Common Ragweed (FD, K, Mo). 8, F-C. Mow; dry open gravelly soil.

Ambrosia psilostachya DC.; Western Ragweed (FD, K, Mo). 2, F-La. Edge; rails sidings, Morley, Big Rapids. Native west of Michigan.

Ambrosia trifida L.; Giant Ragweed (K, Mo). 1, F. Edge; SW cor Jefferson at Front, Stanwood.

Antennaria howellii Greene; Field Pussytoes (FD*). 5, One clump-C. Rt-way; dry open soil.

Antennaria parlinii Fern.; Pussytoes (FD, K). 2, One clump-U. Rt-way; dry open or shaded soil.

***Arctium minus* Bernh.**; Burdock (FD, Mo). 5, F-U. Mow, edge, rt-way; dry or damp soils. Eurasia.

Artemisia campestris L.; Wormwood (FD, K, Mo). 5, Lu-U. Dry disturbed sandy locations.

Artemisia ludoviciana Nutt.; Western Mugwort (FD, K, Mo). 2, Lu. M-20 at WPT northwest. Rt-way; dry field soil. Native west of Michigan. 2090

Aster cordifolius L.; Heart-leaved Aster (K). 4, F-C. Edge; shady areas under trees.

Aster laevis L.; Smooth Aster (K, Mo). 5, Three plants-U. Edge; shady areas under trees.

Aster lanceolatus Willd.; Panicled Aster. 5, F-U. Edge; shady areas under trees.

Aster lateriflorus (L.) Britton; Calico Aster (K, Mo). 6, F-U. Edge; shady areas under trees.

Aster macrophyllus L.; Large-leafed Aster (Mo). 7, F-C. Rt-way; heavily shaded woods.

Aster novae-angliae L.; New England Aster (FD, K, Mo). 2, F-U. Rt-way; open damp areas.

Aster oolentangiensis Riddell; Sky-blue Aster. 1, F. Rt-way; dry soil; just north of 11 Mile Road.

Aster pilosus Willd.; Frost Aster. 8, F-U. Edge, rt-way; open areas.

Aster puniceus L.; Purple-stemmed Aster (K, Mo). 6, F-C. Edge, rt-way; damp shaded and open areas.

Aster sagittifolius Willd.; Arrow-leaved Aster. 10, F-C. Edge, rt-way; shaded and open areas.

Aster umbellatus Miller; Flat-topped Aster (Mo). 3, U. Edge, rt-way; damp shady soil.

Bidens cernuus L.; Nodding Beggar-ticks. 4, Lc-La. Rt-way; damp depressions.

Bidens connatus Willd.; Beggar-ticks. 2, Lc-C. Rt-way; damp depressions.

***Centaurea maculosa* Lam.**; Spotted Knapweed. 10, C-A. Trail, mow, edge, rt-way; dry soil. Eurasia.

***Chrysanthemum leucanthemum* L.**; Ox-eye Daisy (FD, Mo). 10 F-C. Mow, edge, rt-way; dry open soil. Eurasia.

***Cichorium intybus* L.**; Chicory (FD, Mo). 5, Three plants-Lc. Mow, edge, highly disturbed ground; dry, disturbed soils Old World.

***Cirsium arvense* (L.) Scop.**; Canada Thistle (FD, Mo). 3, One plant-U. Edge, rt-way; dry open areas. Eurasia.

Cirsium muticum Michx.; Swamp Thistle. 1, U. Rt-way; wet areas.

***Cirsium vulgare* (Savi) Tenore**; Bull Thistle (Mo). 6, One plant-U. Rt-way; sunny areas. Eurasia.

Conyza canadensis (L.) Cronq.: Horseweed (K). 4, one plant-A. Trail, edge, rt-way; dry gravelly soil.

Coreopsis lanceolata L.; Lance-leafed Coreopsis (K). 3, One plant-F. Rt-way; damp shaded soil.

Erechtites hieraciifolia (L.) DC.; Fireweed (FD). 3, Lu-Lc. Edge, rt-way; damp open soil.

Erigeron annuus (L.) Pers.; Daisy Fleabane (FD*, K). 3, U. Edge; dry ground.

Erigeron philadelphicus L.; Common Fleabane (FD, K, Mo). 4, F-U. Edge, rt-way; dry open ground.

Erigeron strigosus Willd.; Daisy Fleabane (FD*, Mo). 9, F-C. Edge; dry open ground.

Eupatorium maculatum L.; Joe-pye Weed (FD, Mo). 4, U-C. Rt-way; damp shaded depressions.

Eupatorium perfoliatum L.; Boneset (FD, K, Mo). 5, F. Rt-way; damp shaded depressions.

Euthamia graminifolia (L.) Nutt.; Grass-leaved Goldenrod. 5, Lu-U. Edge, rt-way; shady areas.

Gnaphalium macounii Greene; Clammy Cudweed. 1, Three plants. Rt-way; dry gravelly soil.

Helenium autumnale L.; Sneezeweed (FD, K, Mo). 2, One and two plants. Rt-way; wet ground.

Helianthus giganteus L.; Sunflower (Mo). 3, Lu-F. Edge, rt-way; shaded damp soil.

Helianthus tuberosus L.; Jerusalem-artichoke (FD). 2, Four plants-Lu. Edge, rt-way; shaded damp soil.

***Hieracium aurantiacum* L.**; Orange Hawkweed. 2, Lu-F. Mow, edge; dry open soil. Europe.

***Hieracium caespitosum* Dumort.**; Yellow Hawkweed. 7, One plant-C. Mow, edge; dry open soil. Europe.

Krigia virginica (L.) Willd.; Dwarf Dandelion. 1, Lu. Edge; dry open field soil.

Lactuca biennis (Moench) Fern; Tall Blue Lettuce (FD, Mo). 5, Lu-F. Edge, rt-way; shady damp soil.

Lactuca canadensis L.; Wild Lettuce (FD, Mo). 4, One plant-F. Edge, rt-way; shady damp soil.

***Lactuca serriola* L.**; Prickly Lettuce (FD, Mo). 2, Lu-Lc. Edge, rt-way; shady damp soil.

Matricaria matricarioides (Less.) Porter.; Pineapple Weed (FD, Mo). 4, Two plants-F. Trail, mow, edge; gravelly soil and heavily disturbed areas. Western NA.

Prenanthes alba L.; Rattlesnack-root (FD, K, Mo). 5, One plant-U. Edge, rt-way; deep shade.

Rudbeckia hirta L.; Black-eyed Susan (FD, Mo). 5, U. Edge, rt-way; dry open areas.

Rudbeckia lacinata L.; Tall Coneflower (FD, Mo). 2, Three plants-Lu. Edge, rt-way; damp open areas.

Rudbeckia triloba L.; Thin-leafed Coneflower. 1, Lu. Edge; semi-shade north of Stanwood.

Senecio aureus L.; Common Ragwort (FD, Mo). 5, Lu-U. Rt-way; damp semi-shaded soil.

Solidago altissima L.; Tall Goldenrod (Mo). 10, U-A. Edge, rt-way; open field soils, semi-shade.

Solidago caesia L.; Blue-stemmed Goldenrod. 2, Two plants-Lu. Edge; shaded, damp, richer gravelly soil.

Solidago juncea Aiton; Early Goldenrod (Mo). 6, Lc-A. Rt-way; open field soil, semi-shade.

Solidago nemoralis Aiton; Gray Goldenrod (Mo). 8, Two plants-U. Edge, rt-way; dry open, sparsely vegetated areas.

Solidago patula Willd.; Rough-leafed Goldenrod. 1, Three plants. Rt-way; damp marshy soil.

Solidago rugosa Miller; Rough-leafed Goldenrod (Mo). 5, F-U. Edge, rt-way; damp, gravelly, open areas.

Solidago uliginosa Nutt.; Bog Goldenrod (Mo). 1, Three plants. Edge, rt-way; wet marshy soil.

***Sonchus arvensis* L.**; Field Sow Thistle (FD, Mo). 1, Lc. Trail, edge; dry open ground, all depauperate. Europe.
***Sonchus oleraceus* L.**; Common Sow Thistle (Mo). 1, one depauperate plant. Edge; dry ground. Europe.
***Taraxacum officinale* Wiggers**; Dandelion (FD, Mo). 8, F-A. Trail, mow, edge; dry soils, disturbed areas. Eurasia.
***Tragopogon dubius* Scop.**; Goat's-beard. 8, 1 plant-A. Mow, edge, rt-way; dry open areas. Europe.
***Tragopogon pratensis* L.**; Goat's-beard (Mo). 7, F-C. Mow, edge, rt-way; dry open areas. Europe.

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NEW LICHEN RECORDS FROM MICHIGAN AND OTHER CHANGES AFFECTING MICHIGAN SPECIES

Alan M. Fryday
Herbarium
Department of Plant Biology
Michigan State University
East Lansing, MI 48824-1312

Since the publication of the Checklist of lichens and allied fungi from Michigan (Fryday et al. 2001), a number of additional records and other changes have come to my attention. These are presented below. With these additional records, the total number of taxa recorded from Michigan now totals 792 lichens and 42 lichenicolous fungi. All specimens are in MSC unless otherwise stated. The lichenicolous fungi are preceded by an asterisk.

NEW RECORDS FOR MICHIGAN

Agonimia allobata (Stizenb.) P. James
Emmet Co., Wilderness State Park, August 2000, *Fryday 8025*. This is the first record from North America. (Fryday 2001).

Arthonia vinosa Leighton
Washtenaw Co., on old wood,
The specimen in MICH provisionally determined as *A. helvola* is better placed here as the ascospores are mostly (1-)2 septate with only a few 3-septate.

Arthopyrenia cinereopruinosa (Schaerer) A. Massal.
Keweenaw Co., Isle Royale National Park.
A specimen in MICH annotated "like *A. lapponica*, but smaller in all respects" is referable to this species.

Aspicilia grisea Arnold
Alger Co., Deerton, Laughing Whitefish Point, *Lowe* 2475 (MICH).
This is the first record from North America. (Fryday 2001).

Caloplaca ahtii Søchting
Dickinson Co., road into O'Neil Lake campground, September 1971, *Harris 7388*. Ingham Co., Bear Lake, April 1974, *Harris 8666*.
Twelve collections of *Caloplaca holocarpa* in MSC (from three counties in the Upper Peninsula, and nine in the lower) have been re-determined as this species by Dr. U. Søchting (Copenhagen). A further seven collections (from four counties, all in the Upper Peninsula) were annotated "*C.* cf. *ahtii*, could be *C. borealis*."

Caloplaca xanthostigmoidea (Räsänen) Zahlbr.
Charlevoix Co., Beaver Island, August 1961, *Imshaug 27785*.
Chippewa Co., Lower Tahquamenon Falls, August 1957, *Imshaug 19905*.
These two collections (previously included in *C. discolor*) have been re-determined as this species by Dr. C. Wetmore (Minnesota).

***Carbonea supersparsa** (Nyl.) Hertel
Keweenaw Co., Isle Royale National Park, 1957, *Wetmore 567-A*.
Lichenicolous on *Lecanora polytropa*. Determined by Paul Diederich (Luxembourg).

***Dactylospora deminuta** (Th. Fr.) Triebel
Keweenaw Co, Isle Royale National Park, N. of Conglomerate Bay, on ridge around ledges in mixed forest of birch, aspen, spruce and balsam fir (on *Biatora vernalis*), 25 July 1983, *Wetmore 49477* (ASU). (Triebel et al. 1991).

Fuscopannaria confusa (P. M. Jørg.) P. M. Jørg.
Dickinson Co., near O'Neill Lake Campground, *Harris 7502* (MICH). (Jørgensen 2000).

Immersaria athroocarpa (Ach.) Rambold & Pietschmann
Keweenaw Co., Isle Royale National Park, Heron Island in Rock Harbor outside of Tookers Island, 48°09′N 88°29′W, 26 July 1983, *Wetmore 49547* (M). (Hertel 2001).

Micarea neostipitata Coppins & May
Crawford Co., Grayling, Hartwick Pines State Park, on base of *Pinus resinosa*, August 2000. *A. J. Johnson sn.* (Coppins & May 2001).

***Phacopsis oxyspora** (Tul.) Triebel & Rambold
Roscommon Co., 1959, *Imshaug 25458*. Lichenicolous on *Punctelia rudecta*. Determined by Paul Diederich (Luxembourg).

Porpidia contraponenda (Arnold) Knoph & Hertel
Porpidia diversa (Lowe) Gowan (known in Michigan from only Keweenaw Co., Isle Royale National Park) is now considered a synonym of this species (Fryday in press).

Rhizocarpon timdalii Ihlen & Fryday
Keweenaw Co., Isle Royal National Park, south side, of Maskey Bay, *c.* 0.4 miles north of Wallace Lake, 1991, *D. Ladd 15544*. (Ihlen & Fryday 2002).

Sclerophora pallida (Pers.) Y.J. Yao & Spooner
(syn. *S. nivea* (Hoffm.) Tibell (1984). (Yao & Spooner 1999))
Cheboygan Co., on bark of deciduous trees.
Inadvertently omitted from Fryday et al. (2001). Harris (1977) reports this species, as *Coniocybe pallida* (Pers.) Fr., with no further collection details.

***Tremella cetrariicola** Diederich & Coppins
Keweenaw Co., Isle Royale National Park, 1959, *Wetmore 5207*.
Lichenicolous on *Tuckermannopsis ciliaris*. Determined by Paul Diederich (Luxembourg).

Verrucaria macrostoma Dufour ex DC.
Ingham Co., MSU campus, Baker Woodlot, on cement structure in ditch, April 1974, *Harris 8657*.
Previously mis-identified as *Endocarpon pusillum*. The specimen is sorediate, which has been called *Verrucaria macrostoma* f. *furfuracea* B. de Lesd.

DELETIONS FROM THE PUBLISHED LIST

Parmeliella rubiginosa (Ach.) Bory

Peltigera collina (Ach.) Schrader
The single Michigan records of these two species (Keweenaw Co., Isle Royale National Park) are those reported by Hendrick & Lowe (1936). Wetmore (1985) considers that they are probably misidentifications and, as no supporting specimens could be traced, they should be removed from the Michigan list.

Porpidia calcarea Gowan
Synonym of *Porpidia superba* (Körber) Hertel & Knoph (Fryday in press).

Porpidia diversa (Lowe) Gowan
Synonym of *Porpidia contraponenda* (Arnold) Knoph & Hertel (Fryday in press).

Porpidia herteliana Gowan
Synonym of *Porpidia cinereoatra* (Ach.) Hertel & Knoph (Fryday in press).

NOMENCLATURAL CHANGES

The name under which the taxon appeared in the published Checklist (Fryday et al 2001) is given as a synonym. This is followed by a reference to the publication in which the new combination was made.

Amandinea polyspora (Willey) E. Lay & P. May
syn. *Buellia polyspora* (Sheard & May 1997).

Amandinea turgescens (Nyl.) Marbach
syn. *Buellia turgescens* (Marbach 2000).

Chrismofulvea dialyta (Nyl.) Marbach
syn. *Buellia dialyta* (Marbach 2000).

Cladonia arbuscula (Wallr.) Flotow
syn. *Cladina arbuscula* (Ahti & DePriest 2001).

Cladonia mitis Sandst.
syn. *Cladina mitis* (Ahti & DePriest 2001).

Cladonia rangiferina (L.) F. H. Wigg.
syn. *Cladina rangiferina* (Ahti & DePriest 2001).

Cladonia stellaris (Opiz) Pouzar & Vezda
syn. *Cladina stellaris* (Ahti & DePriest 2001).

Cladonia stygia (Fr.) Ruoss
syn. *Cladina stygia* (Ahti & DePriest 2001).

Hafellia arnoldii (Servít) Hafellner & Türk
syn. *Buellia arnoldii* (Hafellner & Türk 2001)

Hafellia disciformis (Fr.) Marbach & H. Mayrhofer
syn. *Buellia disciformis* (Marbach 2000).

Lecidea albohyalina (Nyl.) Th. Fr.
syn. *Biatora albohyalina* (Printzen & Tønsberg 1999).

Mycobilimbia epixanthoides (Nyl.) Vitik., Ahti, Kuusinen, Lommi & T. Ulvinen
syn. *Biatora epixanthoides* (Hafellner & Türk 2001)

Mycobilimbia pilularis (Körber) Hafellner & Türk
syn. *Biatora sphaeroides* (Hafellner & Türk 2001)

Mycobilimbia tetramera (De Not.) Vitik., Ahti, Kuusinen, Lommi & T. Ulvinen
syn. *Biatora tetramera* (Hafellner & Türk 2001)

Protopannaria pezizoides (Weber) P. M. Jørg.
syn. *Pannaria pezizoides* (Jørgensen 2000).

Rhizocarpon reductum Th. Fr.
syn. *R. obscuratum* auct (Fryday 2000).

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PROPOSED LIST OF RARE AND/OR ENDANGERED LICHENS IN MICHIGAN

Alan M. Fryday
Herbarium, Department of Plant Biology
Michigan State University
East Lansing, MI 48824-1312

Clifford M. Wetmore
Department of Plant Biology
University of Minnesota
St. Paul, MN 55108

ABSTRACT

Thirty-four species of macrolichens are considered to be rare and/or endangered in the state of Michigan, with nine being critically endangered. Twenty-five have been recorded from only the Upper Peninsula, seven from only the Lower Peninsula, and two from both peninsulas. Thirteen have been recorded from only Keweenaw County (Isle Royale National Park), but these are considered to be less threatened than the species recorded from only individual or scattered localities elsewhere in the state.

INTRODUCTION

Michigan has an extensive and diverse lichen flora (Fryday et al. 2001). However, although some taxa are known from only a single record in the state, and some are known from nowhere else in North America (Fryday 2001) or even the world (Timdal 1992), none has any legal protection. Based on fieldwork in the Great Lakes region, and the extensive collections in the herbarium of the University of Minnesota (MIN), the second author prepared lists of potentially threatened lichens in Minnesota, Wisconsin, and Michigan. In the summer of 2000, he visited the herbarium of Michigan State University (MSC), and together we revised the list for Michigan by incorporating data from MSC. The final list was completed by including data from the herbarium of the University of Michigan (MICH), obtained during the compilation of the *Checklist of Lichens and Allied Fungi of Michigan* (Fryday et al. 2001).

The final list presented here (Table 1) includes 36 species of macrolichens that are known from five or fewer records from the state of Michigan and that we believe to be threatened in the state. Within these, we have further identified nine species that we believe are critically endangered.

DISTRIBUTION AND RARITY

The lichen vegetation of Michigan is composed of three main elements; species with either a northern, eastern, or Appalachian/Great Lakes distribution. The distribution patterns of other species are unclear because they are known from only scattered records, or their occurrence is too patchy for distribution patterns to be inferred. More detailed distribution patterns for most of the species included here are given by Brodo et al. (2001)

Northern—typically species with a circumboreal distribution. Northern Michigan represents the southern edge of their range and they are often common and widespread further north (e.g. *Arctoparmelia* spp., *Flavocetraria cucullata, Umbilicaria* spp.).

Eastern—terricolous or corticolous species, usually of dry habitats, for which Michigan represents the northeastern edge of their range. Some are widely distributed in the Northern Hemisphere (e.g. *Teloschistes chrysophthalmus*), whereas others are apparently restricted to North and South America (e.g. *Cladonia robbinsii*).

Appalachian/Great Lakes—usually species of humid deciduous woodlands, where their presence indicates an area of old-growth forest. Most are widely distributed, but rare, in the Northern Hemisphere, (e.g., *Sticta fuliginosa*), although *Anzia colpodes* and *Sticta beauvoisii* are apparently endemic to North America.

Within Michigan, there is a distinct division of the species on the proposed list between the Upper and Lower Peninsulas (Table 1). Twenty-five of the 34 species have been recorded from only the Upper Peninsula and two more have been recorded from only the Upper Peninsula and either Emmet or Cheboygan

TABLE 1. Proposed list of potentially threatened lichen species in Michigan.

Recorded from both Upper (Keweenaw Co.) and Lower Peninsulas			
Physcia phaea	(A/GL, N, W)	*Ramalina farinacea*	(W coast, scattered E)
Recorded from only the Upper Peninsula			
Recorded from only Keweenaw Co.		***Not recorded from Keweenaw Co.***	
Arctoparmelia subcentrifuga	(N)	*Anzia colpodes*	(E)
Collema glebulentum	(N)	*Hypogymnia vittata*	(N)
Collema polycarpon	(W)	*Sticta beauvoisii*	(W, scattered C &E)
Flavocetraria cucullata	(N)		
Hypogymnia bitteri	(N)	***Recorded from Keweenaw Co.***	
Lobaria scrobiculata	(scattered N & A)	*Arctoparmelia centrifuga*	(N)
Melenelia tominii	(W)	*Dermatocarpon moulinsii*	(W)
Peltigera venosa	(N)	*Heterodermia leucomela*	(A, W coast)
Pseudocyphellaria crocata	(E & W coast, A/GL)	*Hypotrachyna revoluta*	(scattered)
Punctelia stictica	(scattered W & S)	*Melanelia panniformis*	(N)
Stereocaulon pileatum	(E)	*Protopannaria pezizoides*	(N)
Sticta fuliginosa	(A/GL)	*Psora decipiens*	(N & W)
Umbilicaria polyphylla	(N)	*Ramalina thrausta*	(W, scattered C & E)
Umbilicaria torrefacta	(N)		
Recorded from only the Lower Peninsula			
Cladonia robbinsii	(E)	*Peltigera scabrosa*	(N)
Cladonia strepsilis	(E)	*Teloschistes chrysophthalmus*	(C)
Heterodermia obscurata	(S & E)	*Teloschistes flavicans*	(E & W coasts)
Melanelia albertata	(W & C)		

Key to North American Distribution Patterns:

N - Northern	**C** - Central
S - Southern	**A** - Appalachian
W - West	**GL** - Great Lakes
E - East	

TABLE 2. Michigan counties from which threatened lichen species have been recorded. * = no specimen in MSC, MICH, or MIN; † = species considered critically endangered

Species	Number of counties	Counties in Upper Peninsula	Counties in Lower Peninsula
Anzia colpodes†	1	Luce	
Arctoparmelia centrifuga	2	Keweenaw, Marquette	
Arctoparmelia subcentrifuga	1	Keweenaw	
Cladonia robbinsii†	2		Newaygo, Allegan
Cladonia strepsilis	4		Roscommon, Benzie, Oceana
Collema glebulentum	1	Keweenaw	
Collema polycarpon	1	Keweenaw	
Dermatocarpon moulinsii	2	Keweenaw, Marquette	
Flavocetraria cucullata	1	Keweenaw	
Heterodermia obscurata†	5		Washtenaw, Leelanau, Jackson, Clinton, Iosco
Heterodermia leucomela†	2	Keweenaw*, Alger	
Hypogymnia bitteri	1	Keweenaw	
Hypogymnia vittata	1	Marquette*	
Hypotrachyna revoluta	2	Keweenaw, Delta	
Lobaria scrobiculata	1	Keweenaw	
Melanelia albertana†	1		Cheboygan*
Melanelia panniformis	2	Keweenaw, Marquette	
Melenelia tominii	1	Keweenaw	
Peltigera scabrosa†	1		Clare*
Peltigera venosa	1	Keweenaw	
Physcia phaea	2	Keweenaw	Emmet
Protopannaria pezizoides	4	Keweenaw, Luce, Baraga, Delta	
Pseudocyphellaria crocata	1	Keweenaw	
Psora decipiens†	2	Keweenaw, Chippewa	
Punctelia stictica	1	Keweenaw	
Ramalina farinacea	2	Keweenaw	Cheboygan
Ramalina thrausta	3	Keweenaw, Delta, Chippewa	
Stereocaulon pileatum	1	Keweenaw	
Sticta fuliginosa†	1	Keweenaw	
Sticta beauvoisii	1	Gogebic	
Teloschistes chrysophthalmus†	1		Charlevoix
Teloschistes flavicans	1		Alpena*
Umbilicaria polyphylla	1	Keweenaw	
Umbilicaria torrefacta	2	Keweenaw, Marquette	

Counties, the two most northern counties of the Lower Peninsula. This leaves only seven species that are known from only the Lower Peninsula. Of the 27 species recorded from the Upper Peninsula, 13 have been recorded from only Keweenaw County, usually Isle Royale National Park, and a further 11 species have been recorded from Keweenaw Co. and either elsewhere in the Upper Peninsula (9) or the northern Lower Peninsula (2). Only 11 of the species on the proposed list have not been recorded from Keweenaw County, four from the Upper Peninsula and seven from the Lower (Table 2). This emphasizes the uniqueness of the lichen vegetation of Isle Royale within Michigan. However, many of the species known from only Isle Royale belong to the northern element

of the flora and are common and widespread further north. In contrast, those species known from scattered localities elsewhere in the state are often indicators of undisturbed habitats, which have a high nature conservation interest, and are more threatened by destructive management practices than those on Isle Royale. In Table 2 we have identified nine species that are probably critically threatened in Michigan.

All 34 species of lichen here identified as being threatened in Michigan have a State Rarity Ranking of S1—five or fewer records from Michigan. Global Ranking is less easy to assess although most of the species would probably be ranked at G3—rare, although locally frequent, or G4—apparently secure, although locally rare (Michigan Department of Natural Resources 2001). It should be noted that some microlichens, which are not considered here, would have a Global Ranking of G1—critically imperiled because of extreme rarity, because they are known from five or fewer records world-wide (see below).

DISCUSSION

We have restricted the list to only foliose and fruticose species (macrolichens), omitting the crustose (microlichen) species even though some of these are probably genuinely rare. For instance, *Toninia superioris* has been recorded from only Isle Royale, Keweenaw Co. (Timdal 1992), and *Caloplaca parvula* is known from only the Great Lakes region (Wetmore 1994), whereas for others (e.g. *Aspicilia grisea*, *Agonimia allobata*) the only known North American collections are from Michigan (Fryday 2001). As crustose lichens are easily overlooked and less often collected than macro-lichens, their distribution patterns are poorly understood and it is possible that all these species are less rare than current records indicate. Consequently, we feel that any attempt to designate any crustose species as "threatened" would be premature. However, we have included the squamulose species *Psora decipiens*, because it is a distinctive species with a specialized habitat (base-rich soil) and is less likely to be overlooked than most microlichens.

Four records are not supported by a specimen in MIN, MSC or MICH (Table 2). These are literature references, taken from Harris 1977 (*Melanelia albertana, Peltigera scabrosa, Teloschistes flavicans*) or Manierre 1999 (*Hypogymnia vittata*). Specimens supporting the Harris records are probably held in the herbarium of the University of Michigan Biological Station, Cheboygan County, and the Manierre record is supported by a specimen in the private collection of the Huron Mountain Club, Marquette County.

In addition to their intrinsic value, lichens are important biological indicators of undisturbed habitats. Many species have a need for ecological continuity of habitat, because of their poor recolonizing ability, and are, as such, excellent indicators of important habitats such as old-growth forests or unmanaged prairies. Several species on the list are in this category (e.g. *Cladonia robbinsii, Lobaria scrobiculata, Sticta fuliginosa*). Also, although it is not considered threatened in Michigan, *Menegazzia terebata* is a species with an Appalachian/Great Lakes

distribution that is restricted to old-growth forests. Therefore, it is a useful indicator species for this type of habitat, which have potential for yielding species that are on the threatened list.

The total number of accessioned Michigan collections in MIN, MSC and MICH is around 35,000, although many thousands more are unprocessed. There has also been little organized fieldwork in the state in recent years. Along with the recent lichen checklist for the state (Fryday et al. 2001), the production of this list of threatened species is a further step towards the serious study of this neglected group of organisms in Michigan.

ACKNOWLEDGEMENT

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THE BIG TREES OF MICHIGAN
29. Betula papyrifera Marshall var. cordifolia (Regel) Fern.
Mountain Paper Birch

Kenneth M. Hiser & Elwood B. Ehrle
Department of Biological Sciences
Western Michigan University
Kalamazoo, MI 49008

The largest known Mountain Paper Birch tree in Michigan, as well as in the United States, is located near the Sleeping Bear Dunes in Leelenau County, in the northwest portion of the lower peninsula. Voss (1985) does not recognize this element, nor do Barnes & Wagner (1981). It is accorded specific rank in Flora of North America (as *Betula cordifolia* Regel); clearly, there is some lack of unanimity among taxonomists.

Description of the Species: The Mountain Paper Birch is a member of the Birch family, Betulaceae. In Michigan, the family is represented by a number of large shrub and tree genera. Members of the Birch family are typically monoecious, producing catkins of unisexual, apetalous flowers, both kinds of catkins on the same tree. These appear before leaves are mature in spring, and are wind-pollinated. Voss (1985) distinguishes between two tribes within the family, Betuleae and Coryleae. The two tribes are most readily differentiated according to their fruit and inflorescence. The fruit of Betuleae is a samara, while that of Coryleae is a wingless nut. Betuleae produce elongate, cone-like inflorescences, while Coryleae produce shorter and raceme-like inflorescences. These and other features indicate that Betuleae are the more primitive tribe.

Within the tribe Betuleae, *Betula* is characterized as having solitary pistillate catkins which disintegrate when ripe (those of *Alnus* are clustered and persistent) (Hora 1981). The bark of *Betula* is often papery and peeling, with horizontally elongated lenticels. The leaves are alternate, pinnately veined, and doubly serrate. The trees are monoecious, with male and female catkins borne separately on an individual tree. Male catkins form in the fall and overwinter, while female catkins emerge in spring (Barnes & Wagner 1981).

The Mountain Paper Birch has a samara with wings broader than the body, and scales on female flowers with the middle lobe prolonged (see Fig. 1). The leaves have hairs in the lower lateral veins beneath; the leaves are solitary on long shoots and in clusters of three on spur shoots. The variety *cordifolia* is characterized as having a cordate leaf base; moreover, the trunks tend to be more upright, rather than leaning, and there may be a chromosomal difference between it and typical *B. papyrifera*.

Location of Michigan's Big Tree: From Glen Arbor, the tree can be located by taking M-109 west 2.2 miles to the stop sign in Glen Haven. From the stop sign, a left turn (south) leads about one mile to Harwood Road. If one turns right on

FIGURE 1. Location in Michigan of the state and national champion and characteristics of the Mountain Paper Birch. The asterisk indicates the county where Michigan's Big Tree is located. Illustration no. 1 is from Sargent (1922), where *cordifolia* as a separate species is recognized; illustrations 2–8 are from Barnes & Wagner (1981), of typical *Betula papyrifera*. 1. Flowering twigs (male left, female right) with leaves ×½. 2. Fruit, samara, ×5. 3. Winter twig, ×1. 4. Flowering twig, ½. 5. Male flower, enlarged. 6. Silhouettes of female bracts, in winter, from three trees, ×1. 7. Bract with female flowers, enlarged. 8. Portion of winter twig, enlarged.

Harwood Road and proceeds, the tree will be found near the roadside, along the second curve, about 0.4 mile down the road.

Description of Michigan's Big Tree: The circumference of the tree at four and a half feet above the ground was measured at 112″ (284 cm) [Diameter=36″ (91 cm)]. Its height was measured at 67′ (20.4 m), with a crown spread of 80′ (24.4 m).

INVITATION TO PARTICIPATE

If you would like to join us in extending this series of articles by visiting and describing one or more of Michigan's Big Trees, please contact Elwood B. Ehrle for help with locations, specifications for taking measurements, and assistance with the manuscript. The Michigan Botanical Club encourages your involvement in this activity. Please remember to ask permission before entering private property.

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THE BIG TREES OF MICHIGAN
30. Betula pendula Roth
European White Birch

Kenneth M. Hiser & Elwood B. Ehrle
Department of Biological Sciences
Western Michigan University
Kalamazoo, MI 49008

The largest known European White Birch tree in Michigan is located northwest of Traverse City in Leelenau County in the northwest portion of the Lower Peninsula.

Description of the Species: The European White Birch is a member of the Birch family, Betulaceae. In Michigan, the family is represented by a number of large shrub and tree genera. Members of the Birch family are typically monoecious, producing catkins of unisexual flowers lacking petals. These appear before leaves are mature in spring, and are wind-pollinated. Voss (1985) distinguishes between two tribes within the family, Betuleae and Coryleae. The two tribes are most readily differentiated according to their fruit and inflorescence. The fruit of Betuleae is a samara, while that of Coryleae is a wingless nut. Betuleae produce elongate, cone-like inflorescences, while Coryleae bear shorter and raceme-like inflorescences. These and other features indicate that Betuleae are the more primitive tribe.

Within the tribe Betuleae, *Betula* is characterized as having solitary pistillate catkins which disintegrate when ripe (those of *Alnus* are clustered and persistent) (Hora 1981). The bark of *Betula* is often papery and peeling, with horizontally elongated lenticels. The leaves are alternate, pinnately veined, and doubly serrate. The trees are monoecious, with male and female catkins borne separately on an individual tree. Male catkins form in the fall and overwinter, while female catkins emerge in spring (Barnes & Wagner 1981). The localities shown on Voss' map (Fig. 1) are specimens from trees that have escaped from cultivation or from trees persistent from cultivation, where a home may once have existed.

The European White Birch may be identified at first sight by silvery-white bark and ascending branches with slender, drooping branchlets. Because of these two features, it is also known as the Silver or Weeping Birch. At closer inspection, the twigs are reddish and ovate to deltoid leaf blades are doubly serrated and attached to long, slender petioles. The wings of the samara are broader than its body. The leaves are alternately arranged and are borne singly on long shoots and in pairs on spur shoots (Barnes & Wagner 1981).

Location of Michigan's Big Tree: From Traverse City, the tree can be located by taking M-22 north, through the intersection with M-72 West, to the traffic light at Cherry Bend Road. Turn left on Cherry Bend Road; the tree is located about 1¾ miles from the traffic light (about ⅓ mile past Breithaupt Road). The

FIGURE 1. Documented distribution in Michigan and characteristics of the European White Birch. Map is from Voss (1985). The asterisk indicates the county where Michigan's Big Tree is located. Illustrations are from Brown (1938). 1. Twig showing pistillate and staminate aments ×½. 2. Bract and bracteoles from staminate ament showing stamens, ×7. 3. Staminate flowers with subtending bracts and sepals, ×7. 4. Pistillate flowers with subtending bracts, ×15. 5. Bract and bracteoles from staminate ament showing stamens, × 7. 6. Winged nutlet, ×4. 7. Scale from fruiting strobilus, ×4. 8. Twig with mature leaves and fruiting catkins, ×½. 9. Winter twig, ×½.

tree is easily visible from the road in the front yard of a yellow farmhouse at 9510 Cherry Bend Road.

Description of Michigan's Big Tree: The trunk of the tree divides at just above 4.5 feet into four branches and a main trunk. The circumference of the largest of the four branches was measured at 117″ (297 cm). The circumference of the main trunk at breast height is 158″ (401 cm) [Diameter= 50″ (128 cm)]. The crown has a spread of 71′ (21.5 m), and has been pruned and trimmed considerably. The height of the tree was measured at 78′ (23.75 m).

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THE BIG TREES OF MICHIGAN
31. Acer saccharinum L.
Silver Maple

Charles A. Wade
Department of Biology
C.S. Mott Community College
Flint, Michigan 48503

David G. Mitchell
322 Avenue C
Newberry, Michigan 49868

Elwood B. Ehrle
Department of Biological Sciences
Western Michigan University
Kalamazoo, MI 49008
woodyehrle@aol.com

The new state champion Silver Maple is also the new national champion. It is located in Michigan's Upper Peninsula in Luce County, NE of Newberry, MI, at McPhee's Landing on the Tahquamenon River in section 22 of T 46 N, R 9 W.

Description of the Species: The Silver Maple is a member of the family Aceraceae. There are at least eight species of maples in Michigan. The Silver Maple leaf is quite distinctive. It has three main lobes with narrow sinuses between them (See Fig. 1). The terminal lobe is more than one-half the length of the entire leaf blade. The sinuses between the lobes are acute at the base, forming a distinct angle. The lobes are frequently toothed all the way to the base of each (Voss, 1985). The under surface is usually a silvery green and the upper surface is a darker green. Fall leaf color is usually bright orange-red, becoming yellow later in the season.

The Silver Maple flowers early in the spring, usually in March or April. The flowers have no petals and appear before the leaf buds open. The 6–10 bud scales are red. The flowers appear in lateral, leafless umbels (Gleason & Cronquist, 1991). Some of the flowers are only staminate, while others are perfect with both stamens and pistils. The fruits are paired samaras which are each 3–6 cm long. The two samaras are attached to one another by their bases, forming a 90-degree angle with their wings pointing out. Many times only one of these samaras will have a live seed. The fruits typically mature in May and are wind dispersed. As soon as the fruits land on suitable ground, the seeds germinate (Barnes & Wagner, 1981).

The twigs are chestnut brown, slender and smooth. The inner bark of the twig produces a nasty odor when it is broken or crushed. The bark of the young branches is thin, smooth, and gray. The bark of older twigs and branches is dark gray and somewhat furrowed, spreading into loose, scaly plates that often flake off (Barnes & Wagner, 1981).

Silver Maples are common in the southern portion of the Lower Peninsula of

FIGURE 1. Documented distribution in Michigan and characteristics of the Silver Maple. Map is from Voss (1985). The asterisk indicates the location of the state and national Champion Silver Maple. Illustrations are from Barnes & Wagner (1981). 1. Winter twig, ×1. 2. Portion of twig enlarged. 3. Leaf, ×½. 4. Male flowering twig, ×1. 5. Male flower, enlarged. 6. Female flowering twig, ×1. Female flower enlarged. 8. Fruit, samarax, ×½.

Michigan. They are usually found in floodplains along large rivers and in moist bottomlands of small rivers and creeks. They are sometime found in swamps that have plenty of water movement (Kricher, 1988; Barnes & Wagner, 1981; Curtis, 1959).

Many people plant Silver Maples in their landscapes and they survive quite nicely (Barnes & Wagner, 1981). They are also widely used as street trees. It is reommended, however, that they not be planted too close to buildings or powerlines, because they are brittle and become a hazard. The crotches are usually nar-

row and weak, resulting in the loss of branches during wind and ice storms. Silver Maples are fast growing. They are also moderately long-lived. The wood is hard and pale brown in color.

Silver Maples are found less frequently in the northern Lower Peninsula. They are also known in the Upper Peninsula of Michigan from a few disjunct sites (Merz, 1978). The state and national champion grows in one of these sites. Normally, Silver Maples are found in association with Eastern Cottonwood, *Populus deltoides;* American Elm, *Ulmus americana;* Red Maple, *Acer rubrum;* Box-elder, *Acer negundo;* and Northern Hackberry, C*eltis occidentalis* (Barnes & Wagner, 1981).

Location of Michigan's Big Tree: The state and national champion Silver Maple is located northeast of Newberry in Michigan's Upper Peninsula. The tree is growing on the southern bank of the Tahquamenon River about 7 m from the water in normal years. The tree is about 100 m east of the boat launch at McPhee's Landing at the end of County Road 462. To get to McPhee's Landing from Newberry, Michigan, go north on M-123 out of Newberry. County Road 462 is about one-half mile past the railroad tracks. Take County Road 462 east until it ends at the Tahquamenon River.

Description of Michigan's Big Tree: The trunk of the tree is becoming hollow. The hollow portion is small and has signs that animals are occupying it. Much of the original trunk of this tree died years ago, leaving a trunk base about 5 m tall. Below this the tree sprouted and produced many branches. Because of this, there are many large trunks growing straight up. In November of 1999, one of these large branches fell in a severe windstorm. The portion of the tree that fell was 77 feet (23.5 m) long. The stump that was left is 18 feet (6m) tall. The tree is very old and the bark is covered with lichens and bryophytes at its base. This tree is growing in a floodplain of the Tahquamenon River and old high water marks are apparent on the bark from past floods. There are many holes in the dirt around the tree roots probably produced by digging animals and the action of floodwaters.

Ehrle (1997) had earlier reported that the largest Silver Maple in Michigan had a girth of 297 inches (754 cm), a height of 79 feet (24.1 m) and a crown spread of 77 feet (23.5 m). The new champion has a girth of 347 inches (881 cm) a height of 115 feet (35.1 m) and a crown spread of 61 feet (18.6 m). In order to be the state champion tree only the girth in inches is considered, but a calculated score determines the national champion tree. The score is determined by adding the girth in inches to the height in feet and adding one-quarter of the crown spread. The previous national champion tree is in Columbus, WI. It has a girth of 293 inches (744 cm), height of 115 feet (35.1 m) and a crown spread of 110 feet (33.5 m) (Fedor, 2002). Its score was 436. The new proposed Michigan national champion tree has a score of 477.25.

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for help with locations, specifications for taking measurements, and assistance with the manuscript. The Michigan Botanical Club encourages your involvement in this activity. Please remember to ask permission before entering private property.

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THE BIG TREES OF MICHIGAN
32. *Platanus occidentalis* L.
Sycamore; American Plane-Tree; Platane

Dennis W. Woodland
Biology Department
Andrews University
Berrien Springs, Michigan 49104

Lynn E. Steil
Science Department
Dowagiac Central Middle School
Dowagiac, Michigan 49047

The largest known sycamore in Michigan is located south of Berrien Springs, Berrien Township, Berrien County.

Description of the Species: The sycamore or American plane-tree is our only native representative of the genus *Platanus*, which is in turn the sole genus of the Platanaceae. Worldwide, there are eight species, three of which are native to North America. *Platanus occidentalis* is the most wide ranging American species and the only species native in Michigan. The trees can be large, to over 150′ (50 m) tall, and over 250″ (625 cm) in girth. The trunk can be single or there may be several, with a smooth bark at first peeling off in thin plates, giving a mosaic appearance of white to buff to greenish new bark, changing to dark fissures with age (Fig. 1). The leaves are alternate and simple, with prominent green stipules that sometimes persist; the blades are broadly ovate, generally 3–5 lobed, with broad, shallow sinuses; the lobes have smaller teeth along the edge. The petioles are stout and hollow at the base and completely cover the 2–5 cm bud. The twigs are smooth, slender, pale green, and somewhat zigzag in nature.

The wood is not strong, but hard, tough, and difficult to work. Its resistance to splitting has made it useful for butchers' blocks, button, and for boxes, furniture, and finish trim. The flowers are unisexual, with both staminate and pistillate flowers on the same tree, and the trees are wind pollinated. The pistillate flowers are in dense round heads, and form fruit balls at maturity in the autumn; these "balls" hang on the branches through the winter. The fruit is a beaked, club-shaped achene surrounded by many hairs almost as long as the achene itself.

Location of Michigan's Big Tree: The State Champion sycamore is located 4.8 miles south of the center of Berrien Springs, and 2.8 miles west of Old Highway 31, along Lake Chapin Road at the overpass across U.S. 31 (also called the St. Joseph Valley Parkway), on state property in Berrien Township, section 25, T6S, R18W. The tree is out in the open on the north side of the overpass at the end of the service road.

Description of Michigan's Big Tree: The tree has a very healthy single trunk with four large branches arising at ca. 12' (4 m) above the ground and with very little dead wood. The circumference of the tree at breast height was measured on 26 November 2001 at 258″ (655 cm); in diameter, it is 81″ (202 cm). The crown spread was 96′ (29.3 m). The height was measured at 120′ (35 m). This is a newly found champion and replaces the previous one (225″ in diameter in 1983)

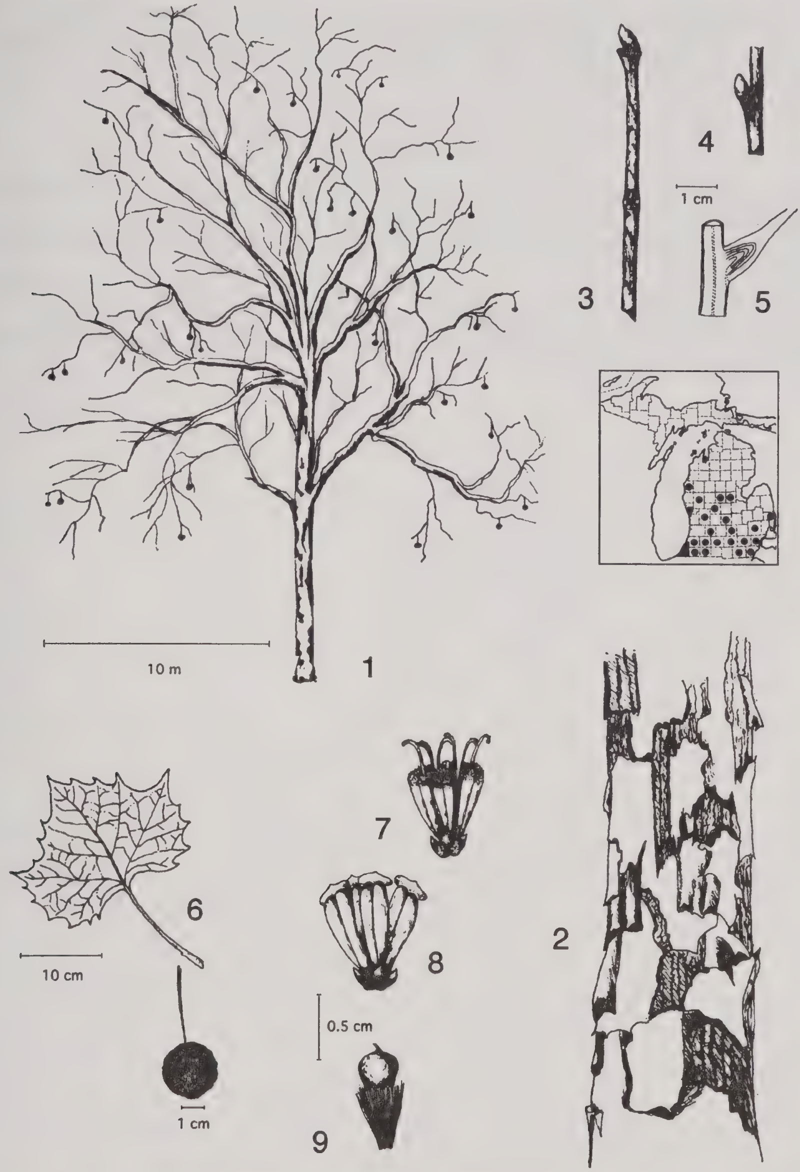

FIGURE 1. Documented distribution in Michigan and characteristics of the sycamore. Map from Voss (1985). The shaded county in the extreme SW corner of the state indicates the location of Michigan's Big Tree. Illustrations 1 and 2 are by Lynn E. Steil; 3, 4, 5, 7, 8, and 9 are from Barnes & Wagner (1981); and 6 is from Woodland (2000). 1. Habit of mature tree during winter, showing hanging multiple fruits; 2. mottled bark showing plate-like scales; 3. twig with winter buds and leaf scars; 4. lateral bud; 5. lateral bud encased in enlarged base of petiole; 6. palmately veined and lobed leaf with mature, ball-like multiple fruit; 7. female flower with multiple carpels, each carpel with a curved style; 8. male flower with four stamens; 9. achene with hairs attached at the base.

found in Kalamazoo County. The severe storm of 25 October 2001 did little damage to the tree. A photograph of the tree is on the cover of a local history publication (Foster 1999).

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Volume 41, numbers 1 and 2, for January and March, 2002, were mailed on 5 September 2002.

On the cover: *Spikenard,* Aralia racemosa. *Roadside woods on Gills Coulee Road, West Salem, La Crosse County, Wisconsin, 14 August 2002. The plant is a herbaceous perennial, with dark purple fruits, sometimes two meters high and arching over other vegetation. Photo by Richard Kent Helman, an avid birdwatcher, who sent the photo for identification and kindly granted permission to publish it.*

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Address changes should be directed to James Doyle, 631 Covell Avenue NW, Grand Rapids, MI 49504; 616. 459. 8281 (office); 616. 453. 5407 (home); jdoyle59@attbi.com

On all editorial matters, please contact: Neil A. Harriman, Editor, Biology Department, University of Wisconsin-Oshkosh, Oshkosh, WI 54901; 920. 424. 1002 (office); or at 5188 Bittersweet Lane, Oshkosh, WI 54901; 920. 233. 1973 (home); harriman@uwosh.edu – please use e-mail whenever possible.

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ASCLEPIAS VERTICILLATA AND ROADWAYS OF THE UPPER MIDWEST: FROM HOME ON THE RANGE TO LIFE IN THE FAST LANE

Duane D. McKenna
Department of Organismic and Evolutionary Biology
Harvard University
26 Oxford Street, Cambridge MA 02138
dmckenna@oeb.harvard.edu; 617. 492. 1478

INTRODUCTION

Asclepias verticillata L. (whorled milkweed) is a native perennial member of the family Asclepiadaceae. Stems (ramets) are usually 20–80 cm tall and bear small white flowers (sometimes with green and/or purple highlights) in umbels. The seed-pods (follicles) are usually 1 cm wide and 6–8 cm long. The leaves are numerous, entire, 2–8 cm. long, 2–5 mm wide, and are produced in whorls. The plant (a genet) grows from a shallow underground rhizome and can bear from one to many above-ground stems. *Asclepias verticillata* has laticifers that exude sticky white latex when damaged. It is distributed from southern Manitoba, Ontario, Wisconsin, Michigan, New York and Massachusetts, south into Florida and the Gulf States, and west to Montana, Wyoming, Colorado, and New Mexico. Throughout this range it is reported from a diversity of habitats including dry to dry-mesic prairies, savannas, thin woods, roadsides, pastures, rocky cliffs, and old fields (Braun 1989; Gleason and Cronquist 1991; Mohlenbrock 1986; Voss 1996).

In June of 1994 I found thousands of flowering stems of *A. verticillata* in the median of US highway 131, just north of its intersection with Shaver Road in Kalamazoo County, MI. I later found plants to be exceptionally abundant in similar conditions elsewhere in Kalamazoo County. Prior to these discoveries I had thought *A. verticillata* to be nearly extirpated in the vicinity of Kalamazoo.

To determine if *A. verticillata* occurred along additional highway, and interstate roadsides in the upper Midwest (here defined as Indiana, Illinois, Michigan, and Ohio), I visually surveyed for plants along roadsides in this region over the following 6 summers.

METHODS

I looked for *A. verticillata* while driving along interstate, and highway roadsides in Illinois, Indiana, Michigan, and Ohio between spring 1995 and fall 2000. These informal surveys involved watching for *A. verticillata* along the roadside while driving, and making notes on a hand-held voice recorder of any stretches of road greater than 5 miles in length where *A. verticillata* was not observed. Plant abundance and distribution were not explicitly measured, but stretches of roadside where *A. verticillata* was not observed were noted. Several herbarium specimens were collected as vouchers from each state and are part of the author's personal collection.

In Michigan I surveyed interstate 94 between the Indiana state line and Detroit, interstate 75 between Mackinac and Flint, interstate 69 between Lansing and the Indiana state line, US 131 between Grand Rapids and Schoolcraft, interstate 96 between Grand Rapids and Detroit, interstate 196 between Benton Harbor and Grand Rapids, US 23 between Flint and the Ohio state line, US 27 between Lansing and interstate 75, US 127 between Lansing and Jackson, and US 2 between St. Ignace and Ironwood.

In Ohio I surveyed tollway 80/90 between the Michigan state line and Sandusky, and interstate 70 between the Indiana state line and Columbus.

In Indiana I surveyed interstate 80/94 between the Illinois and Michigan state lines, interstate 65 between interstate 80/94 and Roselawn, US 17/1/114/10 between the Illinois state line and Roselawn, tollway 80/90 between interstate 69 and the Illinois state line, US 41 between interstate 80/94 and interstate 74, interstate 74 between the Illinois state line and Indianapolis, and interstate 70 between Indianapolis and the Ohio state line. In Illinois, I traveled interstate 57 between interstate 80 and interstate 24, interstate 74 between Peoria and the Indiana state line, interstate 72 between Springfield and Champaign, interstate 70 between St. Louis and Effingham, interstate 55 between Springfield and interstate 70, interstate 80 between interstate 74 and the Indiana state line, and US 17/1/114/10 between Kankakee and the Indiana state line.

All of the aforementioned roads were surveyed while traveling in both directions, and most were surveyed on multiple occasions.

RESULTS AND DISCUSSION

Asclepias verticillata was found to be widespread and abundant along roadsides throughout most of the surveyed region (Figure 1). Along any given one-mile stretch of roadway traveled, plants were far more likely to be observed growing on the roadside than not. *Asclepias verticillata* was absent from the northernmost, southernmost, and easternmost parts of the surveyed area which included US 2 through Michigan's Upper Peninsula, interstate 75 north of Houghton Lake MI, wooded roadsides east of Indianapolis IN along interstate 70, and interstate 57 in southern IL near Marion where the former prairies give way to remnant woodland. Four 5–9 mile stretches of US 27 between Lansing and interstate 75 were devoid of this species (not shown in Figure 1). Plants were also absent from relatively short (5–7 mile) stretches of roadside through the heavily urbanized areas of south Chicago IL, Detroit MI, Grand Rapids MI, Indianapolis IN, Lansing MI, and Toledo OH (not shown in Figure 1).

Despite these observations, it appears that *Asclepias verticillata* was probably not especially abundant prior to the widespread settlement and destruction of prairie and savanna communities in the upper Midwest more than 100 years ago. Even in the early 20th century, at least in southwest Michigan, *Asclepias verticillata* was a rare component of remnant dry to dry-mesic savanna (mostly oak barrens and oak openings sensu Curtis 1959), and prairies (Hanes & Hanes 1947). It was by no means known to be common. In fact, until I found plants along the roadside in Kalamazoo County in 1994, I had thought that *A. verticillata* was nearly extirpated in the county. Further, my field experiences elsewhere in Michigan, and with prairie and savanna remnants in Illinois and Indiana suggest that *A. verticillata* is not particularly abundant elsewhere in the upper Midwest in natural or disturbed settings outside of roadsides. Thus, the abundance of *A. verticillata* along roadsides in this region is peculiar.

Why *Asclepias verticillata* occurs so widely along roadsides, while it is still

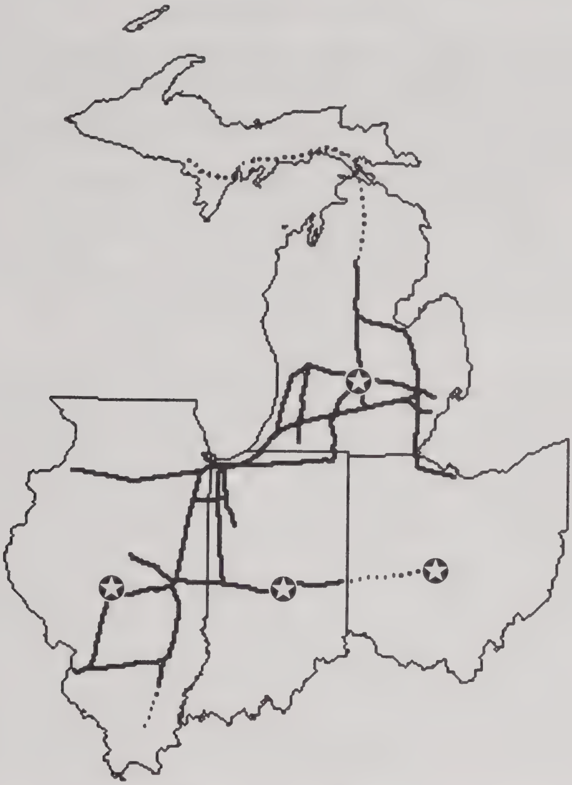

FIGURE 1. Outline map of the upper Midwest (as defined for this study) showing the approximate location of interstates and highways surveyed (see *"Methods"* for names). Solid lines indicate roadways along which stems of *A. verticillata* were generally abundant and widespread (with exceptions noted in *"Results and Discussion"*). Dashed lines indicate roadways (≤25 miles in length) along which plants were not seen. Stretches of roadside from 5 to 25 miles in length where *A. verticillata* was not observed are not shown on the map, but are presented in the *"Results and Discussion"*. State capitols are indicated with stars for orientation.

rare and local in remnant and relict natural communities, and disturbed areas other than roadsides is unclear. Numerous biotic and abiotic factors may be involved including mowing, automobile emissions, and substrate conditions. Additional observations, as well as experimental manipulations may help elucidate the contributions these and other factors make to the abundance of roadside *A. verticillata*.

ACKNOWLEDGMENTS

I give special thanks to my wife Katherine McKenna for her assistance and her support.

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SPATIAL AND TEMPORAL PATTERNS OF EASTERN WHITE PINE REGENERATION IN A NORTHWESTERN OHIO OAK STAND

Scott R. Abella[1] and Neil W. MacDonald
Department of Biology, Grand Valley State University,
Allendale, Michigan 49401-9403

ABSTRACT

Eastern white pine (*Pinus strobus* L.) was often associated with oaks (*Quercus* spp.) on upland sites in presettlement forests of the upper Great Lakes region, but widespread logging and subsequent fires in the late 1800s converted these upland sites to fire-tolerant oak forests. Although white pine regeneration is occurring in these second-growth oak forests, white pine regeneration patterns in oak forests of the Great Lakes region are not well documented. We examined white pine regeneration in the southern Great Lakes region in an oak stand within the Oak Openings region of northwestern Ohio, where white pine plantations established in the 1940s have served as seed sources for white pine invasion of surrounding oak-dominated forests. White pine regeneration was aggregated in high-density clumps in the oak stand, with a mean white pine to white pine nearest-neighbor distance of 1.8 m. Eighty-one percent of invading white pine established during a 6-yr interval that corresponded with an extended period of below-average annual available water deficits (i.e., conditions were more moist than normal). No white pine recruitment has occurred in the oak stand in the last 15 yr since the 6-yr establishment interval, and we hypothesize that favorable white pine colonization sites in the oak stand were occupied during the initial invasion event. White pine regeneration in these oak forests may proceed in "leaps and bounds," with white pine expanding 100–300 m by clumped regeneration into new areas during unique regeneration events. White pine's present ability to reproduce successfully in northwestern Ohio appears related to reductions of historic fire frequencies.

INTRODUCTION

In presettlement forests of the upper Great Lakes region, eastern white pine (*Pinus strobus* L.) occurred in pure stands (Gevorkiantz & Zon 1930; Potzger 1946; Whitney 1987), in mixed stands with red pine (*P. resinosa* Aiton; Harvey 1922), in mixed northern hardwood stands (Nichols 1935; Brown & Curtis 1952), and in mixed *Quercus* stands (Waterman 1922; Maycock 1963; Kurczewski 2000). On dry upland sites, white pine commonly occurred with oaks (*Quercus* spp.) as an understory tree or as a canopy dominant (Kittredge & Chittenden 1929; Kenoyer 1933; Davis 1935). White pine distribution and regeneration success in these presettlement Great Lakes forests depended on substrate, disturbance regimes, climate, and interspecific competition (Whitney 1986).

Pure white pine and mixed white pine-red pine stands developed following catastrophic disturbances such as fire (Maissurow 1935; Hough & Forbes 1943), and white pine in these stands could be self-replacing through regeneration in

[1] Author for correspondence: Ecological Restoration Institute, College of Ecosystem Science, Northern Arizona University, Box 15018, Flagstaff, AZ 86011; sra8@dana.ucc.nau.edu

canopy gaps (Holla & Knowles 1988; Quinby 1991; Ziegler 1995). In mixed northern hardwood forests, white pine regeneration across the landscape was controlled by the distribution of large white pine seed trees and by competition with hardwoods (Palik & Pregitzer 1994; Saunders & Puettmann 1999). Following widespread logging and subsequent fires in the Great Lakes region in the late 1800s, white pine-oak forests on dry sites were converted to oak forests (Kittredge & Chittenden 1929). Although white pine regeneration is occurring in these second-growth oak forests (Elliott 1953; Host et al. 1987; Johnson 1992; Carleton et al. 1996), white pine regeneration patterns are not well documented in oak forests of the Great Lakes region.

We examined white pine regeneration in the southern Great Lakes region in Oak Openings Preserve within the Oak Openings region of northwestern Ohio. Presettlement vegetation in this region was dominated by black oak (*Quercus velutina* Lam.) and white oak (*Q. alba* L.) savannas and woodlands (Sears 1925). White pine did not occur in northwestern Ohio at the time of settlement (Moseley 1928), and the Oak Openings region is about 80 km south of the white pine's native range in southern Michigan. In the mid-1900s, however, white pine plantations were established throughout Oak Openings Preserve in a matrix of oak stands that had undergone succession from savanna or woodland to forest as a result of fire suppression (Abella et al. 2001). These white pine plantations have served as seed sources for white pine regeneration in surrounding oak-dominated forests. Since white pine did not occur in Oak Openings before it was planted in the mid-1900s, we had a unique opportunity to study white pine invasion patterns in an oak-dominated landscape. The objective of this study was to quantify the spatial and temporal patterns of white pine invasion of an oak stand to identify potential white pine regeneration patterns in oak-dominated forests of the Great Lakes region.

METHODS

The 1496-ha Oak Openings Preserve is in Lucas County, northwestern Ohio. We sampled a 5-ha oak-dominated stand (41°33′12′N, 83°50′8″W) in the preserve adjacent to a 0.8-ha white pine plantation. Soils in the oak stand are classified as mixed, mesic Aquic and Typic Udipsamments of the Ottokee and Oakville series (Stone et al. 1980). The oak stand originated about 1930, and the white pine plantation was created in 1947 with trees 3 m apart. In 2001, the plantation contained 43 m^2 ha^{-1} white pine basal area and had a white pine site index of 29 m at 50 yr. All white pine in the oak stand are understory trees and established from seed produced by parent white pine in the plantation once they reached reproductive age.

We sampled white pine regeneration in the oak stand using a stratified-random sampling design in March 2001 by dividing the oak stand into six 0.84-ha blocks and randomly locating one circular 0.1-ha (17.84 m radius) plot in each block. We determined in each plot the species and diameter at 1.4 m of all live trees greater than 1 cm diameter, and we aged white pine to the nearest year by counting branch whorls (Bormann 1965; Sharik et al. 1989; Palik & Pregitzer 1994). For each of the 167 white pine occurring in the 6 plots, we measured to the nearest cm the distance to the nearest white pine and the distance to the nearest codominant or dominant overstory oak (Avery & Burkhart 1983). Nearest neighbors that occurred outside of plots were measured to prevent artificially inflating nearest-neighbor distances for white pine near the outer edges of plots (Clark & Evans 1954; Cottam et al. 1957; Sinclair 1985). Nearest neighbors occurred outside of plots for 7 of 167 white pine measured in our study, and we did not use nearest-neighbor trees that occurred outside of plots in stand density calculations.

To assess the spatial pattern of white pine regeneration in the oak stand, we computed the Clark-Evans index (Clark & Evans 1954) using white pine nearest-neighbor distances for each white pine in the 6 plots. This index is calculated as the ratio of the actual mean nearest-neighbor distance for each individual to the mean nearest-neighbor distance expected if the population was distributed at random (Clark & Evans 1954). An index value of 0 indicates a spatial distribution of maximum aggregation of individuals, a value of 1 indicates a random distribution, and a value of 2.15 indicates a uniform distribution. We tested the significance of the departure from randomness with the standard variate of the normal curve (Clark & Evans 1954). There has been speculation that the Clark-Evans index is biased toward uniform distributions; however, the spatial distribution of white pine in our study was computed as significantly aggregated so we used the original Clark-Evans index (Sinclair 1985). To further assess white pine spatial patterns, we used a two-tailed paired t-test comparing white pine nearest-neighbor distances using data pooled for all plots (167 sampled white pine trees) to test the null hypothesis that the mean white pine to white pine distance did not differ from the mean white pine to overstory oak distance. Plot means were not used for this analysis because our objective was to evaluate stand-level spatial patterns, so we gave equal weight to each white pine sampled in the stand. We also used a chi-square test (degrees of freedom = 1) to test the null hypothesis that the proportion of white pine closest to other white pine and the proportion of white pine closest to an overstory oak were both 0.5.

We integrated climatic factors that may affect white pine seed output and seedling survival by estimating available water deficits (potential evapotranspiration – actual evapotranspiration) on a monthly basis for the period 1955–1994 using the Thornthwaite water balance equation (Mather 1978). Moisture availability in upper soil layers is most likely to affect white pine seedling establishment (Smith 1940; Shirley 1945; Thomas & Wein 1985), so we based available water holding capacity on the upper 50 cm of soil. For the water balance calculations, we obtained monthly precipitation and mean monthly temperature data measured at the Toledo Express Airport in Lucas County, Ohio, 5 km from our study site, from the National Climatic Data Center Summary of the Day database (Earthinfo, Inc., Boulder, CO).

RESULTS

White pine occurred as an understory tree beneath an overstory dominated by several oak species (Table 1, Fig. 1). In addition to white pine, white oak and red maple (*Acer rubrum* L.) were abundant in the understory. The Clark-Evans index was < 1 and indicated that the spatial distribution of invading white pine was significantly clumped in the oak stand, and the mean white pine to white pine distance was less than the mean white pine to overstory oak distance (Table 2). Of 167 white pine sampled, 72% occurred closer to other white pine than to an

TABLE 1. Mean stand variables for live trees > 1 cm diameter for a northwestern Ohio oak stand. SD = Standard Deviation; the "other" category includes *Acer rubrum*, *Sassafras albidum*, and *Prunus serotina*.

	Species			
Variable	*Quercus alba*	*Quercus velutina*	*Pinus strobus*	Other
Density (trees ha^{-1})	223	280	278	262
SD	87	64	229	209
Basal area (m^2 ha^{-1})	5.5	18.4	0.9	1.0
SD	2.8	3.6	1.0	0.4
Diameter (cm)	15.7	28.5	4.4	6.6
SD	4.7	2.0	2.6	2.0

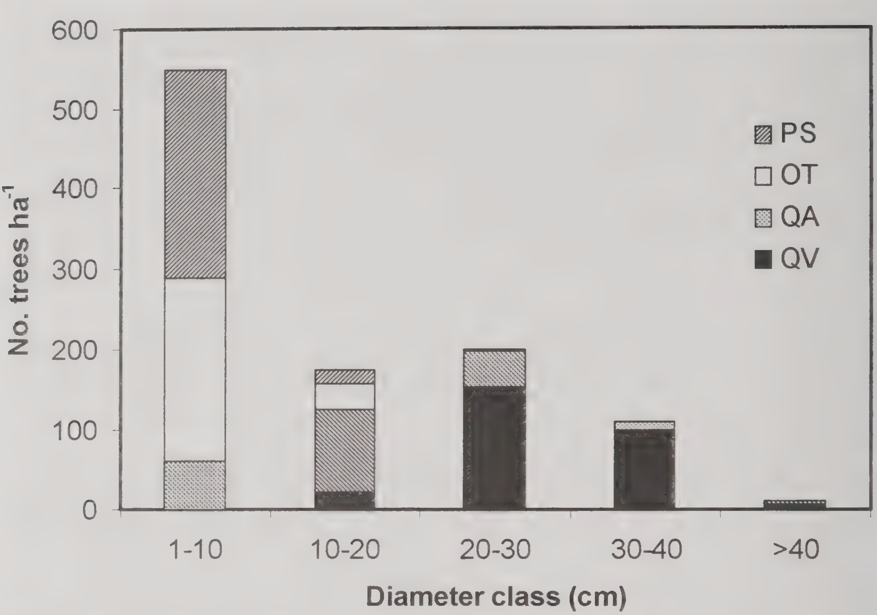

FIGURE 1. Diameter distribution for a northwestern Ohio oak stand. PS = *Pinus strobus*, OT = other (includes *Acer rubrum*, *Sassafras albidum*, and *Prunus serotina*) , QA = *Quercus alba*, and QV = *Quercus velutina*.

overstory oak; this proportion differed significantly from 0.5 (Table 2). Mean age of invading white pine in the oak stand at the time of sampling in 2001 was 20.5 yr (standard error = 0.2). White pine invasion of the oak stand began in 1974 when the parent white pine in the plantation were age 27 yr, and 81% of the invading white pine established in the oak stand between 1977 and 1982 (Fig. 2). This establishment interval corresponded with an extended period of below average annual available water deficits (Fig. 3).

TABLE 2. Summary of spatial patterns of regenerating white pine in a northwestern Ohio oak stand.

Variable	Value	Test statistic	Probability
Clark-Evans index	0.6	$z = 9.9$	< 0.0001
Nearest-neighbor distances		$t = 5.75$	< 0.0001
White pine to white pine distance (m)[1]	1.8 ± 0.1		
White pine to overstory oak distance (m)[1]	2.7 ± 0.1		
Frequency of proximity		$\chi^2 = 33.7$	< 0.0001
No. white pine closer to other white pine	121		
No. white pine closer to an overstory oak	46		

[1] Mean ± standard error.

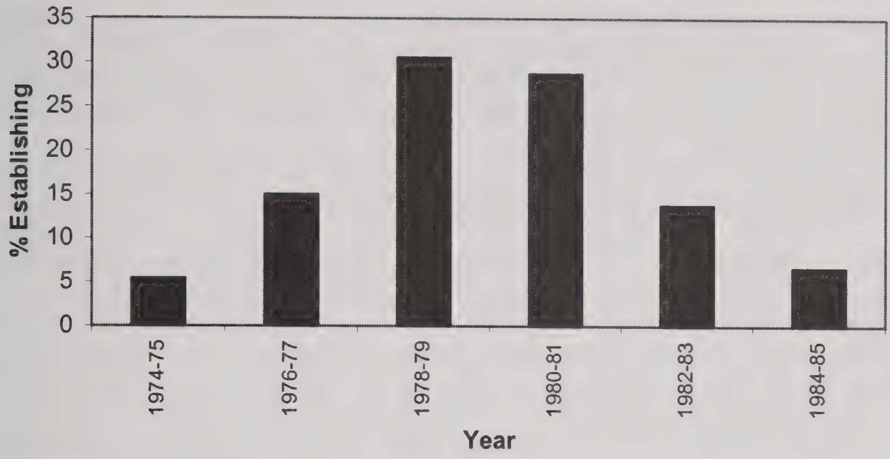

FIGURE 2. Percent of the total white pine sampled (n = 167) establishing in a northwestern Ohio oak stand by 2-yr classes. No white pine established in the oak stand before 1974 or after 1985.

DISCUSSION

Aggregation of white pine regeneration in high-density clumps suggests certain areas in the oak stand were optimal for white pine establishment, although these areas have no known history of disturbance. These optimal zones for white pine regeneration may result from favorable light conditions, favorable seedbeds free from understory competition, or optimal seedbed moisture conditions (Cornett et al. 1998). Peterson and Squiers (1995a, b) also found that white pine regenerated in clumps in a bigtooth aspen (*Populus grandidentata* Michx.) forest in northern Michigan, and these clumps were distributed away from overstory aspen. Hibbs (1982) hypothesized that white pine saplings may reach the overstory in dense hardwood stands of New England through group reproduction where a clump of white pine saplings serves as a buffer from hardwood compe-

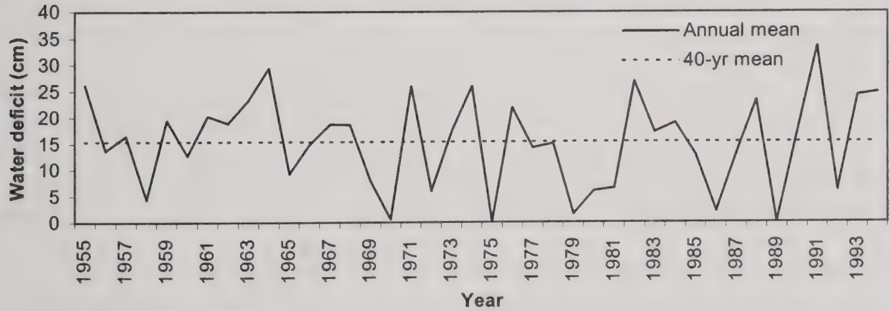

FIGURE 3. Forty-year records of annual available water deficits in the Oak Openings region of northwestern Ohio.

tition around a central white pine. White pine regeneration was also aggregated in pure white pine stands in Ontario (Quinby 1991) and New England (Yeaton 1978). These studies combined with our results suggest that white pine commonly regenerate in clumps in a variety of forest types including oak-dominated forests of the Great Lakes region.

Clumps of regenerating white pine occurred in the oak stand as far as 200–300 m away from the parent white pine in the plantation. These distances are further than those reported by Palik & Pregitzer (1994), who found that little or no white pine regeneration occurred greater than 100–140 m from large white pine seed trees in an aspen forest in northern Michigan. White pine seed is primarily wind dispersed (Burns & Honkala 1990), and the greater dispersal distances we recorded likely result from the open vertical structure of the oak stand that facilitated white pine seed dispersal. Small mammals can also disperse white pine seeds by caching (Burns & Honkala 1990), but it is unlikely that seed caches were the primary dispersal mechanism for white pine seed in the oak stand because most seed caches are eaten in a given year (Smith 1940; Abbott & Quink 1970; Cornett et al. 1998). The distance seeds traveled in the oak stand from the parent trees in the plantation and the large number of white pine establishing during a narrow time frame are consistent with wind dispersal of seed for white pine colonization of this oak stand.

White pine began establishing in the oak stand when the parent white pine in the plantation were age 27 yr, and 81% of white pine regeneration in the oak stand occurred during a 6-yr period. Our results are similar to those of Sharik et al. (1989) in hardwood forests of lower Michigan, who found that residual white pine following catastrophic fire were age 26–37 yr when the first post-fire white pine seedlings originated. White pine invasion of the oak stand in our study corresponded with a 5-yr period of below average available water deficits, indicating that moisture stress was low during white pine seedling establishment. The onset of seed production by plantation white pine, corresponding with a climatic period favorable for white pine seedling survival, created optimal conditions for white pine regeneration during their establishment interval in the oak stand (Burns and Honkala 1990).

Aggregation of white pine regeneration, the narrow time span of invasion, and the lack of subsequent recruitment suggest that white pine invasion of the oak stand was a discrete event. This invasion event was facilitated by initial seed produced by the parent white pine in the plantation, favorable white pine regeneration sites available in the oak stand, and favorable climatic conditions for white pine seedling survival. Lack of subsequent white pine recruitment in the oak stand since 1985 is probably not due to a lack of seed because good white pine seed years generally occur every 3–5 yr (Burns & Honkala, 1990). Climatic conditions characterized by low available water deficits, similar to those during the initial invasion event, also have occurred since 1985 but did not correspond with further white pine regeneration in the oak stand.

Our results suggest that most of the favorable white pine colonization sites in the oak stand were occupied during the initial invasion event, and intraspecific competition with established white pine clumps occupying favorable regeneration sites in the oak stand has inhibited subsequent recruitment. Several estab-

lished white pine in the oak stand, however, are currently growing greater than 0.5–1 m yr^{-1} and will eventually reach the overstory (Hibbs 1982). These white pine are nearing reproductive age with a mean age of 20.5 yr and will begin to produce seed that may initiate white pine invasion of other adjacent oak stands. White pine regeneration in these oak forests may proceed in "leaps and bounds," with white pine expanding 100–300 m by clumped regeneration into new areas during unique regeneration events following the onset of seed production by maturing trees.

Although white pine did not occur in the Oak Openings region at the time of settlement, its present ability to reproduce successfully in northwestern Ohio appears to be related to human alteration of historic disturbance regimes. Moseley (1928) noted that the complete absence of conifers in the Oak Openings region was "peculiar," and the sandy soils of Oak Openings are similar to those in lower Michigan where white pine was abundant in presettlement forests (Waterman 1922; McCool & Veatch 1924; Veatch 1928). Before settlement, oak savanna and woodlands in the Oak Openings region burned frequently and intensely (Bourne 1820), and small white pine cannot survive frequent fire (Kittredge & Chittenden 1929; Burns & Honkala 1990). Following logging in Michigan in the late 1800s, for example, intense fires scorched upland areas formerly dominated by white pine, eliminating regenerating pine and favoring fire-tolerant oaks (Beal 1888, 1902; Kittredge & Chittenden 1929). Similar burning regimes occurred historically in the Oak Openings region (Bourne 1820; Moseley 1928), and white pine's present ability to reproduce successfully in northwestern Ohio likely results from human suppression of the presettlement fire regimes that white pine could not have survived.

ACKNOWLEDGMENTS

We thank Toledo Area Metroparks for their cooperation and Denise Gehring for providing a map of pine plantations in Oak Openings Preserve. We also thank John Jaeger, Carol Griffin, Shaily Menon, and Kelly Coughlin for assistance with this project, and Mel Northup for providing climatic data for northwestern Ohio. This paper is partly based on portions of an undergraduate thesis completed by the senior author while attending Grand Valley State University.

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OBITUARY

Howard A. Crum (1922–2002)

The Great Lakes botanical community lost a highly regarded colleague with the passing of Dr. Howard Crum on 30 April 2002. Virtually anyone who studied mosses, lichens, or peatlands in the Great Lakes region has probably come in contact with Dr, Crum, either in person, in the classroom or the field, or from reading one of his many articles and books. Members of the Botanical Club may also remember Howard as the second editor of *The Michigan Botanist*, taking over the reins from Dr. Edward Voss in 1977 and continuing until 30 April 1984.

Howard received his B.S. from Western Michigan University in 1947, completing his graduate degrees at the University of Michigan (M.S. in 1949, Ph.D. in 1951). His "Michigan connection" resumed when he returned to the University of Michigan in 1965 as an Associate Professor of Botany and Curator of Bryophytes at the UM Herbarium. Over the next 35+ years, he did many things to both advance our knowledge of the bryophytes of our area as well as impart this knowledge to others. Howard taught courses about mosses, lichens, and peatland ecology both on the main campus in Ann Arbor and at the Biological Station at Pellston, continuing to spend summers there after his official retirement as Curator Emeritus in 1995. While much of his research dealt with the classification and distribution of the genus *Sphagnum* (peat mosses), he also ranged more broadly among the bryophytes of the Great Lakes region. His book *Mosses of the Great Lakes Forest,* a definitive work which first appeared in 1973, is still used as a text in several college classes. Howard was working on a fourth revision of the work at the time of his passing. The other volumes that Howard wrote which involve Great Lakes subjects are his *Liverworts and Hornworts of Southern Michigan* (1991) and *A Focus on Peatlands and Peat Mosses* (1988).

While I have just touched on a few of the highlights of his career, readers who would like to read an extensive account of his life and a bibliography (to 1992) should consult the following article: Anderson, L.E. 1992. A tribute to Howard Crum. Contributions from the University of Michigan Herbarium 18: 3–38. This article was written by one of Howard's colleagues as an introduction to a collection of papers assembled as a celebration of Howard's 70th birthday.

Richard K. Rabeler
University of Michigan Herbarium
3600 Varsity Drive
Ann Arbor, Michigan 48108-2287
rabeler@umich.edu

HARD OR FAIRGROUNDS GRASS (*SCLEROCHLOA DURA*, POACEAE) IN THE GREAT LAKES REGION

Allison W. Cusick
Museum of Biological Diversity,
The Ohio State University,
1315 Kinnear Rd. Columbus, Ohio 43212

Richard K. Rabeler
University of Michigan Herbarium,
3600 Varsity Drive
Ann Arbor, Michigan 48108-2287

Michael J. Oldham
Ontario Natural Heritage Information Centre
Ministry of Natural Resources, PO Box 7000
Peterborough, Ontario, K9J 8M5, Canada

ABSTRACT

First reported in the Great Lakes region from an athletic field near Cincinnati, Ohio in 1990, *Sclerochloa dura* has now been located in at least 162 additional sites, most during the last seven years on fairgrounds. This species is now known from seven states and Ontario in the region; first reports from Pennsylvania, West Virginia, and Wisconsin and the rediscovery of *Sclerochloa dura* in New York are presented here. We present several theories in an attempt to account for this distribution; most feature some type of transport of equipment or animals between fairgrounds.

Non-native species usually are found in generalized habitats. Their distribution and frequency are dependent upon their abilities to invade and rapidly colonize disturbed sites. Examples of such opportunistic and widespread species in North America include *Taraxacum officinale* Weber, *Poa annua* L. and *Plantago lanceolata* L. Native species, to the contrary, usually are restricted to specific habitats, often ones of exceedingly narrow biological parameters. Many well-known rarities are examples of this situation, such as *Cypripedium candidum* Muhl. and the U.S. federally-listed *Trifolium stoloniferum* Muhl.

Our work in the Great Lakes region over the past seven field seasons suggests that *Sclerochloa dura* (L.) P. Beauv. (Poaceae) may present a remarkable reversal of this pattern. This species has specific preferences of soil and disturbance. When these conditions exist, the grass usually is present. Indeed, the predictability of locating *Sclerochloa dura* plants is remarkable; given the proper factors, the species likely will be found, often in abundance and seemingly firmly established. *Sclerochloa dura* colloquially is known as hard grass or fairgrounds grass. The name "hard grass" refers to the firm, almost bony glumes. "Fairgrounds grass", first appearing in Swink and Wilhelm (1994), alludes to its affinity for the types of habitat and disturbance found on fairgrounds.

COLLECTION HISTORY

Sclerochloa dura (Fig. 1) is a annual species of the Poöideae native from southern Europe to western Asia (Tsvelev 1984). It is considered to be a "good

FIGURE 1. *Sclerochloa dura* plants, St. Joseph County fairground, Centreville, Michigan. Photo taken by Rabeler, May 1999.

pasture plant" (Rozhevitz 1934) in "spring ephemeral pastures" (Tsvelev 1984) of Russia. Brandenburg et al. (1991) summarized the collection history of this species in North America. It first was collected in 1895 near a woolen mill in Yonkers, New York. This population apparently failed to survive as it was not recollected anywhere in New York state until 2000: R. S. Mitchell, pers. comm. and *Rabeler 1429,* BH, CM, MICH, NYS, US (abbreviations follow Holmgren et al. 1990). By 1944, *S. dura* had been found in seven western states: California, Colorado, Idaho, Oregon, Texas, Utah (the site of the first western collection in 1928), and Washington. In the following decades, the species spread to Arkansas, Kansas, Missouri, Nebraska and Oklahoma. The first recent collection east of the Mississippi River was made in Georgia in 1982. By 1991, single collections had been made in four other eastern states: Maryland, Ohio, Tennessee, and Mississippi (Brandenburg et al. 1991). This brought the total to eighteen states as of 1991. Recent North American collections outside of the Great Lakes region have also been made in Iowa (Eilers and Roosa 1994), Louisiana (Saichuk et al. 2000), Arizona (Reeder 2001), and British Columbia, Canada (Oldham 2001).

Although this distribution is extensive, the number of documented populations in almost any state is exceedingly few. This clearly can be seen in the dot map in Brandenburg et al. (1991) where the occurrence of *S. dura* in 10 of 18 states is based on single populations.

Within the Great Lakes region, the first collection of hard grass was made in

1990 from an athletic field near Cincinnati (Hamilton Co.), Ohio (*Cusick 28795 & Baird*, MICH, MU). In 1992, Ken Dritz located the species at four sites in Illinois and one in Michigan (Swink and Wilhelm 1994); these were the first collections for these states. The first Indiana record was gathered in 1993 (*Beard 166*, MOR). All of these six recent collections had an important factor in common; they were made in county fairgrounds, often in or near arenas for showing and racing horses.

A FAIRGROUNDS SURVEY

In 1995, Cusick began a systematic survey for exotic species at fairgrounds in Ohio. Such sites are common in the state; there is at least one fairground in each of the 88 Ohio counties. Agricultural fairs long have played a significant role in the Midwest. In addition to county fairs, there also are a host of 4-H, Junior, FFA (Future Farmers of America) and independent fairs in the Midwest. Some urban counties retain a fair as a symbol of their past agricultural heritage, e.g., the Cuyahoga and Hamilton county fairs in the Cleveland and Cincinnati areas respectively. Cusick soon discovered that fairgrounds are a rich and neglected source of county and state distributional records, particularly those of spring ephemerals. Dritz apparently noted a similar pattern in the Chicago region (Swink and Wilhelm 1994). The typical fairground offers large grassy expanses, park-like settings of mature trees, broad roadside shoulders, gravel and dirt roadbeds, weedy edges of buildings and, most importantly, racetracks and facilities for horses (arenas, barns, and show rings) . Opportunistic invaders have an ideal setting for propagation and survival, depending on the maintenance or the lack thereof. Events at most fairgrounds are scheduled during summer and fall months. Species blooming and fruiting in the spring can attain full development before the flurry of weeding and cleaning begins prior to the event season.

It quickly became obvious that *Sclerochloa dura* was a common and significant element in the fairground flora in Ohio. Extensive populations often were located, particularly in association with equestrian facilities. Cusick "introduced" hard grass to both other authors in early 1997, interesting them to expand the search in Michigan and Ontario. Michael A. Vincent of Miami University also was recruited to help survey for hard grass in Indiana and Ohio.

As a result of this survey, *Sclerochloa dura* has been added to the floras of Pennsylvania, West Virginia, Wisconsin, and Ontario, Canada. Oldham's collections from two Ontario fairgrounds in 1997 were the first in Canada (Oldham 1998, Oldham et al. 1998). The species also was relocated in New York state where it had not been reported for more than a century. Specimen citations for these records are given in Appendix I.

We now appreciate how frequent hard grass is in the Great Lakes region; there are now 145 documented populations of *S. dura* at fairgrounds in this area. *Sclerochloa dura* is not an uncommon species of widely scattered occurrence. Instead, it is a common element of a circumscribed habitat. This habitat has not received much attention from botanists in the past and thus a widespread species

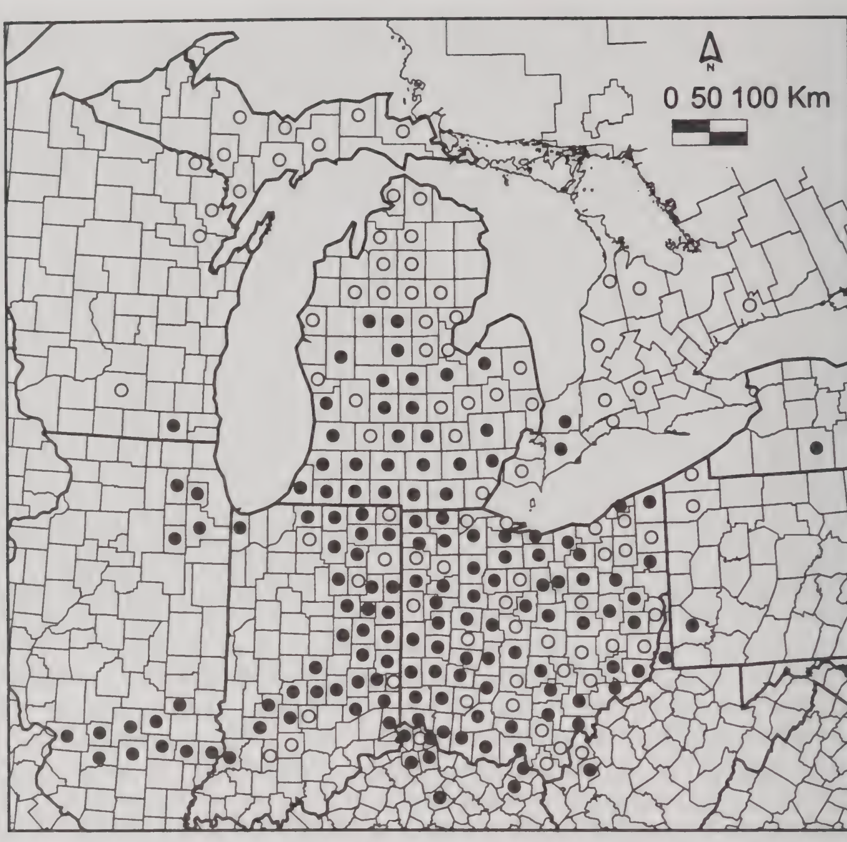

FIGURE 2. Fairground occurrences of *Sclerochloa dura* in the Great Lakes region. Dots = counties where *S. dura* is known from one or more fairgrounds. Circles = counties where at least one fairground was searched without success.

has been overlooked. The map in Figure 2 summarizes our present knowledge of the occurrence of *Sclerochloa dura* at fairgrounds in the Great Lakes region. This is based on fairgrounds surveyed by one or more of the authors during the past seven years. The dots represent counties in which *Sclerochloa* was found in at least one fairground while open circles indicate counties where we have searched one or more fairgrounds but did not locate *S. dura.* The "known/absent" tally by counties in states/provinces where we have surveyed extensively is: Indiana, 32/8; Michigan, 27/33; Ohio, 59/28; Ontario, 2/10. Our surveys in other states have been minimal with only a few sites surveyed. Vouchers for these collections are mostly at MICH and OS. Collections by others included in this map are by Dritz (four near Chicago; at MOR) and Beard (St. Joseph Co., Indiana; at MOR). Many of the hard grass populations at these sites are extensive. The ground is often virtually carpeted with mats of *S. dura* in the spring.

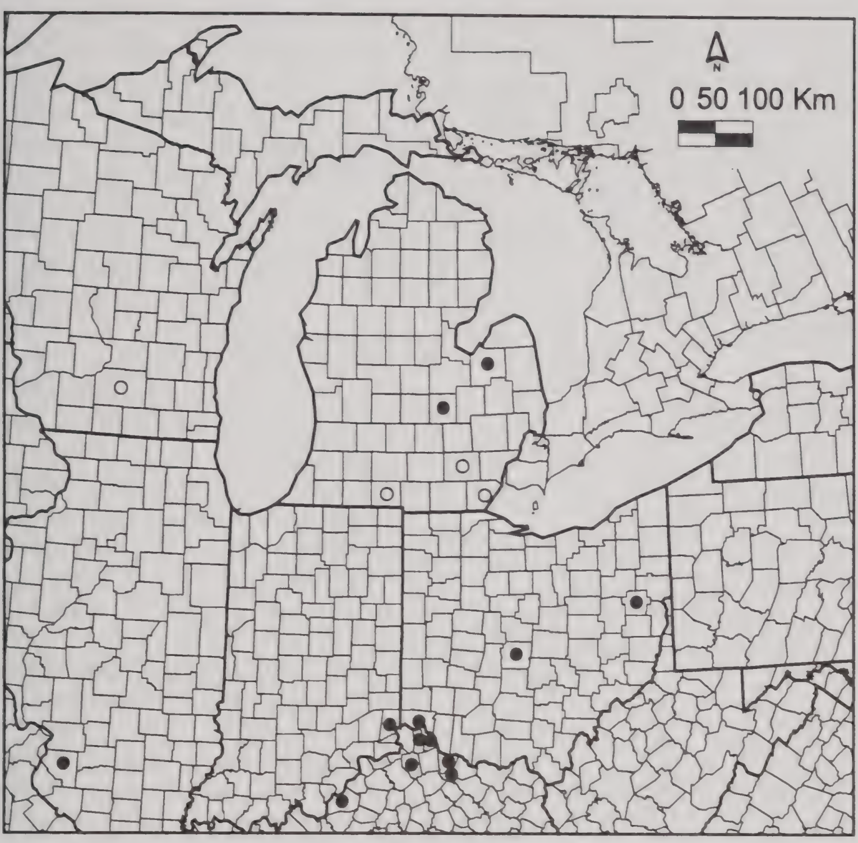

FIGURE 3. Athletic fields occurrences of *Sclerochloa dura* in the Great Lakes region. Dots = counties where *S. dura* is known from one or more fairgrounds. Circles = counties where at least one fairground was searched without success.

ATHLETIC FIELDS

Brandenburg et al. (1991) noted that *Sclerochloa dura* was often found in "the most disturbed areas in playgrounds and athletic fields" (p. 370). Brandenburg and Thieret (1996) reported the first records of hard grass in Kentucky from athletic fields. They visited 12 such sites in northern Kentucky, finding hard grass in nine of them. They postulated that the seeds were transported from site to site in mud on athletic shoes.

Figure 3 illustrates the known occurrences of *Sclerochloa dura* on athletic fields in the Great Lakes region. As in Figure 2, open circles indicate counties where at least one athletic facility was searched without success. Beyond the Cincinnati area (where most of the collections were made by J. W. Thieret), *S. dura* has seldom been found in similar settings. One of two such Michigan locations consists of a few plants growing on an athletic field in the middle of a race-

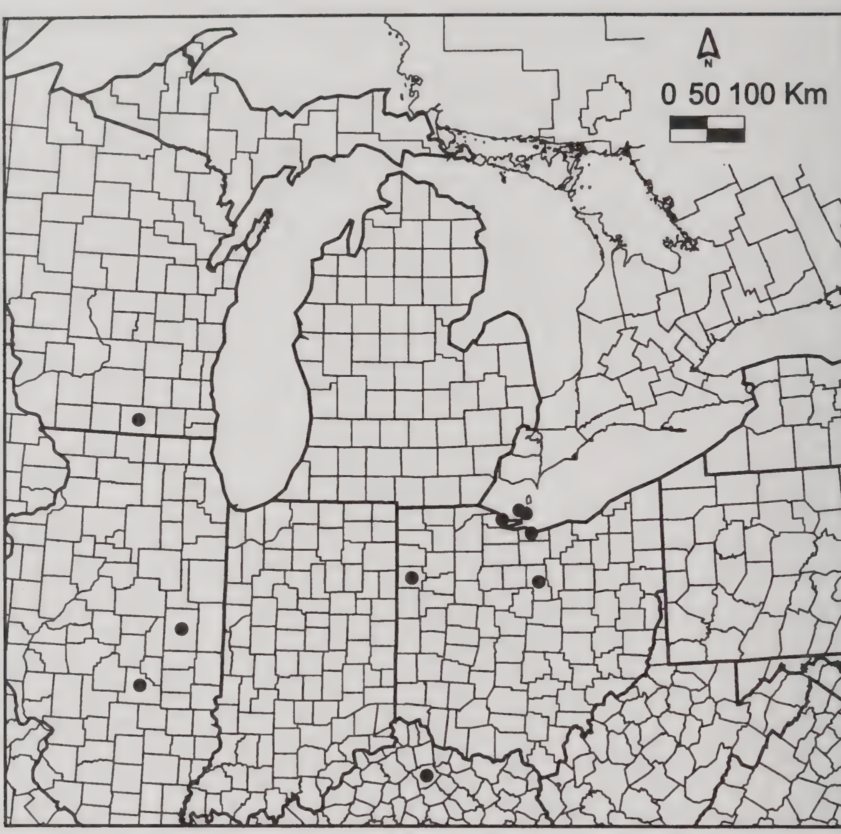

FIGURE 4. Occurrences of *Sclerochloa dura* in other habitats in the Great Lakes region.

track at the Tuscola County fairgrounds (*Rabeler 1406 & Cusick*, MICH). A similar hybrid habitat with hard grass is at the Shelby County, Indiana, fairground where hard grass is common (*Cusick 34838 & Vincent*, MU). A related habitat is the clay surface adjacent to tennis courts in a Columbus, Ohio, city park (*Cusick 34895*, OS).

OTHER HABITATS

Sclerochloa dura has been found only sparingly in other habitats in the Great Lakes Region. These occurrences are mapped in Figure 4; all collections except a Champaign Co., Illinois collection (*Hill 27815* at ILLS) are by the authors. Many of these sites are graveled parking lots and roadbeds. On Ohio's Lake Erie islands, hard grass is well-established at ferry docks and marinas. The single Kentucky collection is from muddy earth at a boat ramp (Harrison County, *Cusick 35266*, MICH). Brandenburg et al. (1991) stated that *S. dura* also was

known from "campsites, roadsides, golf courses". It is also known from a few agricultural sites. Saichuk et al. (2000) found it along the edge of a road in a rice field in northeast Louisiana, Charles Bryson collected it in reduced tillage soybean and no-till cotton fields in west-central Mississippi (*Bryson 16268,* MICH), and hard grass is found along field edges in southeastern Missouri (G. Yatskievych, pers. comm.). In our experience, such occurrences are in the minority in the Great Lakes states. In spite of the prevalence of hard grass at fairgrounds, we do not yet know of any reports of this species being found in an agricultural setting in the Great Lakes region.

SUBSTRATE AND ASSOCIATES

In reporting *Sclerochloa dura* as new to Missouri, Ladd (1983) noted it was found in "severely disturbed, usually compacted" sites. Compacted clay is a common denominator for many fairground populations of *S. dura*. Contrary to the often-cited habitat preference of sandy or gravelly soils (Chase 1951, Yatskievych 1999), a clay substrate seems to be directly correlated to the occurrence and frequency of this species on such sites. We have found repeatedly that the most likely places to find *S. dura* are the clay surfaces of race tracks and the roadways immediately adjacent to the track. This relationship is also illustrated in the map in Figure 2. Hard grass is apparently absent from most fairgrounds north of central Michigan. Sand, rather than clay, is a far more common substrate in Michigan north of Saginaw Bay (Cusick & Rabeler, pers. obs.)

In these sites, *Sclerochloa dura* can be abundant and form a monoculture or may appear with some combination of the following associates: *Polygonum aviculare* L., *Matricaria discoidea* DC., *Lepidium ruderale* L., *Poa annua* L., *Poa bulbosa* L., *Hordeum pusillum* Nutt., and *Scleranthus annuus* L. This "fairgrounds association" may actually have an Old World origin. It is interesting to note that the first three species in this list are the primary associates in the *Sclerochloo-Polygonetum avicularis*, or "parched Hardgrass-Knotgrass carpet" (Ellenberg 1988) vegetation community which occurs sparingly along dry, heavily trampled or trodden areas (especially roads) of central Europe, particularly Germany (Korneck 1969) and Czechoslovakia (Sládek 1997) and other Balkan countries. It appears that the fairground provides a large expanse of similar conditions; dry, often hard, compacted sites devoid of plants that cannot withstand the damage that trampling and disturbance will cause. The phrase "track plants" that Ellenberg (1988) used to describe plants that inhabit such areas has far more significance in our case than we suspect he intended!

INTRODUCTION AND SPREAD OF *SCLEROCHLOA DURA*

Given the preponderance of fairground populations of *Sclerochloa dura* in the Great Lakes region, we feel it likely that the spread of this species is tied to the transport of animals, equipment, and/or supplies between fairgrounds. We sug-

gest that some of the populations may have come from states to the west and southwest of the Great Lakes. Hard grass is known from many sites from Missouri and Kansas to Texas. The species grows in at least two fairgrounds in eastern Texas, Collin County (*Rabeler 1318*, MICH) and Red River County (*Rabeler 1325*, MICH) and many in Kansas (C. Freeman, pers. comm.). Cusick and Vincent have found on Indiana and Ohio fairgrounds other species with mainly southern and western distributions, e. g., *Monolepis nuttalliana* (Roemer & Schultes) Greene and *Sibara virginica* (L.) Rollins. Swink and Wilhelm (1994) recorded both of these species in the Chicago region, noting *Sibara* as "introduced from the south" and *Monolepis* as "introduced from farther west".

How is *Sclerochloa dura* transported from place to place? As it is most abundant in areas around racetracks, show rings and horse barns, a likely option is with bedding, feed or horse trailers. The seeds, or more likely the whole inflorescences, may be carried in earth caked on vehicles. Two observations, though, are at odds with this suggestion. First, as noted earlier, we have not found *S. dura* in agricultural lands outside a fairground in our area. This is puzzling if transport from farm to fair and return is involved. Secondly, *S. dura* is absent from some of the fairgrounds in the Amish settlements of central and northeast Ohio. We would expect to find it widespread in those areas where horses are so common.

Tractor pulling and other racing events are common activities taking place on fairgrounds. Many competitors in these events are from out-of-state locales. Perhaps *Sclerochloa dura* is transported in the earth adhering to tractors and pulling sleds and other vehicles which travel to and from such events. Similarly, amusement company vehicles also might spread hard grass. At one Michigan fairground, the *S. dura* occurs in the fair's midway area; the amusement rides and refreshment stands here are provided by a company from central Ohio. An occurrence in Madison County, Ohio, is on the site of the state's annual Farm Science Review. Farming equipment is transported to this area from throughout the Midwest. The Clark County, Ohio, fairgrounds is famous for its large antique and flea markets which draw buyers and sellers from hundreds of miles away. *Sclerochloa dura* grows abundantly in this fairground as it does at several other fairgrounds hosting similar events.

Clearly there are many avenues for the spread of this grass through the Great Lakes states and beyond. In this regard, the spread of *Sclerochloa dura* mirrors the dispersal of zebra mussel, *Dreissena polymorpha* (Pallas), from the Great Lakes to the Mississippi drainage. The mussels adhere to bottoms of boats and travel in that manner from one body of water to another. People are urged to clean boats and equipment before removing them from the water, a suggestion which is seldom complied with and difficult to enforce (D'Itri 1997).

THE FUTURE OF *SCLEROCHLOA DURA* IN THE GREAT LAKES REGION

Sclerochloa dura is an adventive species that is highly opportunistic. While it can be found in thick, lush carpets of erect plants (e.g. Fig. 5, Madison Co., OH),

FIGURE 5. "Turf" of large, erect *Sclerochloa dura* plants, Molly Caren Agricultural Center, Madison County, Ohio. Photo by Rabeler, May 1999.

most of the time we see it as tiny prostrate plants barely consisting of more than a few leaves and an inflorescence (e.g., Fig. 1, Centreville, MI). This clearly shows the physiological amplitude that would make *Sclerochloa dura* a successful weed. Brandenburg et al. (1991) noted that it was able to outcompete other weedy species in severely trampled areas. Dispersal of the plant appears to be by either the plant fragmenting or via the entire inflorescence (Brandenburg et al. 1991). Planting an inflorescence results in an instant "colony" rather than just a single individual (Rabeler, pers. exp.). This would give *Sclerochloa dura* an important advantage for species establishment in new areas. The species gets multiple chances to establish itself.

Brandenburg et al. (1991) stated that *Sclerochloa dura* was both "under-collected and under-reported". We have clearly demonstrated that to be the case in the Great Lakes region. During the course of our work, we have seen several of the populations appear and grow rapidly; e.g. the populations near the ferry docks on the Lake Erie islands. If, as in some areas, *Sclerochloa dura* continues to "escape" from fairgrounds and athletic fields, we feel that it definitely has the potential to become a widely distributed species of disturbed areas.

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Appendix I: Collection data for new state and provincial records of Sclerochloa dura and its rediscovery in New York.

CANADA. **Ontario**. Kent Co.: Ridgetown Fairground, Howard Twp., 42°26′50″N, 81°52′40″W, 20 May 1997, *Oldham 19674* (DAO, MICH, TRT, WAT); Lambton Co.: open, moist disturbed area, Brigden Fairgrounds, Sombra Township, ca. 20 km SSE of Sarnia, 42°48′20″N, 82°16′50″W, 22 May 1997, *Oldham & Cusick 19702* (DAO, MICH, TRTE).

UNITED STATES. **New York**. Allegany Co.: pulling track/arena, Cuba Fire Department Park, W end of Woodruff St., 0.3 mi W of jct. with Genesee St. (NY 305), 0.5 mi S of jct. of NY 305 & I-86 (NY-17), Cuba, 2 June 2000, *Rabeler 1429* (BH, CM, MICH, NYS, US). **Pennsylvania**. Washington Co.: area of racetrack and stables, county fairgrounds, N Main St., N of Arden Station Rd., N of Washington, 24 April 2001, *Cusick 35788* (MICH, OS); gravel roadbeds, fairgrounds, N of US 40, West Alexander, 24 April 2001, *Cusick 35790* (MICH, OS). **West Virginia**. Putnam Co.: gravel roadbed at horse show ring, county park, N of WV 62 at Eleanor, 20 April 1998, *Cusick 34223* (MICH, OS). **Wisconsin**. Rock Co.: edge of sidewalk, N edge of parking area at railroad depot, 100 ft S of jct. of Main St. (US 51) & Fulton St. (WIS 59), Edgerton, 42°49.993′N, 89°04.196′W, 19 May 2001, *Rabeler 1461* (MICH). Walworth Co.: margin of racetrack surface, SW corner of arena, Walworth Co. fairground, 0.1 mi SE of main entrance along WIS 11 (E Court St.), 0.4 mi E of jct with WIS 67 (Wisconsin Ave.), Elkhorn, 20 May 2001, *Rabeler 1466* (MICH, MOR, OSH, WIS).

NOTEWORTHY COLLECTION

MICHIGAN

Subularia aquatica L. (Brassicaceae). Water Awlwort.

Previous Knowledge: Subularia aquatica is an aquatic member of the mustard family that occurs in eastern Asia, Europe, and the northern part of North America (Voss 1985). According to Crow & Hellquist (2000), the North American taxon of *S. aquatica* is ssp. *americana* Mulligan & Calder. In northeastern North America, this annual species grows in shallow water of lakes, ponds, and slowly-moving streams (Crow & Hellquist 2000). In the Great Lakes region, *S. aquatica* has been documented from Minnesota (state threatened), New York (state endangered), and Ontario where, although not a listed species, it is considered rare (Oldham 1999). In Michigan, its status was recently changed from state threatened to state endangered (MI DNR & MNFI 1999).

Significance: Until its discovery in Keweenaw County's Gratiot Lake, *Subularia aquatica* had been documented in Michigan from only two locations. These historical records, both from Michigan's Upper Peninsula, were from Isle Royale in 1930 and the St. Mary's River in 1958 and 1965 (Voss 1985).

Diagnostic characters: Subularia aquatica forms a rosette of long, narrow leaves up to 5 mm long (Gleason & Cronquist 1991). Its minute white flowers have, like most other members of the mustard family, four petals, four sepals, and six stamens. Roots of *S. aquatica* are extremely white compared to roots of other rosette-forming aquatic species with which it may be confused (Paul Monson and Lynden Gerdes, pers. comm.).

KEWEENAW CO.: in shallow water of lake, rooted in mucky bottom, fruiting, Gratiot Lake Conservancy, Gratiot Lake, T57N R30W, 30 July 2000, *Marr 2816* (MICH, !A.A. Reznicek). Associates include *Eriocaulon aquaticum* (Hill) Druce, *Isoetes* sp., *Lobelia dortmanna* L., and *Chara* sp.

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—Janet Keeney Marr
23180 Highway Location Road
Calumet, Michigan 49913

NOMENCLATURE OF THE NARROW-LEAVED FRINGED GENTIAN OF THE GREAT LAKES REGION, *GENTIANOPSIS VIRGATA* (RAF.) HOLUB (GENTIANACEAE)

James S. Pringle
Royal Botanical Gardens,
P.O. Box 399, Hamilton, Ontario, Canada L8N 3H8
jpringle@rbg.ca

Many readers will be familiar with the spectacular displays of the narrow-leaved fringed gentian in flower that appear each fall at such popular naturalists' destinations as Waugoshance Point and Grass Bay in Michigan and Dorcas Bay, Petrel Point, and St. Jean Point on the Bruce Peninsula in Ontario. With this species being so well known and so much admired, it is unfortunate that its correct specific epithet has long been in question.

Historically, this species was known as *Gentiana procera* Holm. Now it is generally placed in *Gentianopsis* Y.C. Ma, as substantial morphological and molecular evidence indicates that the fringed gentians are more closely related to certain other, widely accepted genera than to *Gentiana* in a stricter sense. As a species of *Gentianopsis*, it was initially called *G. procera* (Holm) Y.C. Ma. More recently, it has sometimes been designated *G. virgata* (Raf.) Holub. Gillett (1982) was apparently the first definitely to associate this name with the species hitherto called *G. procera*, as consultant on *Gentianopsis* for the United States Department of Agriculture *National List of Scientific Plant Names*, and in annotations of specimens at DBN in 1986 (Nelson & Dore 1987). This name was also adopted in the second edition (1984) of Morton & Venn's *Flora of Manitoulin Island*, in the Ontario floristic lists by Morton & Venn (1990) and Newmaster et al. (1998), in the *Checklist of vascular plants of Bruce and Grey counties*, Ontario (Bruce-Grey Plant Committee 1995), and in other Ontario checklists in which those references were followed. The epithet *virgata* dates from late 1837, and thus has 64 years' priority over *procera*, if these epithets are considered to be applicable to the same species.

Holub (1967), in making the combination *Gentianopsis virgata*, did not discuss the identity of the plants to which the name was applicable, the typification of the name, or its possible heterotypic synonymy. Earlier, Gillett (1957) had included the basionym *Anthopogon virgatum* Raf. in the synonymy of *Gentianella crinita* subsp. *procera* (Holm) J.M. Gillett "ex char." At that time he included the taxon *procera* within *G. crinita* at the rank of subspecies, and therefore was not faced with the question of the priority of the epithets at the rank of species. Kartesz (1994) and Cooperrider (1995) cited the names *Gentianopsis procera* and *G. virgata* as taxonomic synonyms, but rejected the latter without comment. Voss (1996) also designated this species *Gentianopsis procera*, with the comment that "there has been some attempt recently to resurrect an old name, which

I am not fully convinced applies to this species, in the combination *Gentianopsis virgata*."

Rafinesque (1837) initially gave the range of his *Anthopogon virgatum* as "Canada and Alleghany [sic] mts." The species considered here is not found in the Alleghenies, but it does occur in what was then and is now Canada. About a year later, Rafinesque (1838) excluded the Allegheny plants from his circumscription of *A. virgatum*, designating them *A. incarnatum* Raf., and thereby restricting his concept of *A. virgatum* to the Canadian plants. Rafinesque (1838) described *A. incarnatum* as having leaves "narrower than in *A. crinitum*, broader than in *A. virgatum*." This further supports the interpretation of Rafinesque's *A. virgatum* from Canada as being taxonomically equivalent to the plants later called *Gentiana procera*.

Rafinesque's only visit to Canada was in the spring of 1826, too early in the season for fringed gentians to have been recognizable, but he could have seen specimens of Canadian origin in the herbaria of other botanists whom he had visited.

One of the botanists whom Rafinesque visited was John Torrey. From specimens that I had examined during my doctoral studies, I remembered that eastern North American gentians from Torrey's herbarium, now at NY, had been annotated by Rafinesque. I have identified the annotations as his because the annotator was familiar with names being considered by Rafinesque whether or not they ever appeared in print; they occur only in association with names attributed to him; and the handwriting resembles that of Rafinesque on labels at PH, as illustrated by Mears (1978). The usual format is the proposed name, attributed to "Raf.," usually with the designation "N. Sp.," followed by "Med. Fl.," "Monogr. Med. Fl.," or "Monogr." (Rafinesque published a *Medical Flora* in 1828–1830, but few of these annotated names appeared in it. Soon thereafter he began work on a supplementary volume, but it was never published.) I therefore looked for such an annotation among the fringed gentians from Torrey's herbarium, and found one with Rafinesque's annotation "Beautiful N. Sp."; on the next line, "G. virgata Raf. Monogr."; and on the next two lines, in the same handwriting but slightly smaller, "Anthopogon genus Necker 1790." A label elsewhere on the sheet, perhaps supplied with the specimen by James or William McNab, says "Collected in Canada 1834." Between "Canada" and "1834" someone else, presumably Torrey, inserted "by Mr. W. McNab." (Actually it was William McNab's father, James, who was in Canada in 1834.) This specimen represents the narrow-leaved fringed gentian historically known as *Gentiana procera* and called *Gentianopsis virgata* here and in the publications cited above. James McNab is known to have collected this species 18 August 1834 by the estuary of the Maitland River at Goderich, in present-day Huron County, Ontario (Nelson & Dore 1987).

Further evidence that Rafinesque's description of *A. virgatum* was based at least in part on a specimen from Torrey's herbarium appears in the similarity between it and Torrey's (1843) own description of "*G. detonsa*." Both, for example, included the minor detail of the cauline leaves being narrowed at the base, which is scarcely perceptible except in the lower leaves. Although this might be coincidental, it might also be due to Rafinesque's having discussed this species

with Torrey. Because the McNab specimen noted above was seen and annotated by Rafinesque and clearly indicates to what Canadian species he applied the name *Anthopogon virgatum*, I hereby designate it the lectotype of that name.

Another epithet to be considered is *ventricosa*, published at species rank by Grisebach in July 1837, a few months earlier than Rafinesque's *virgatum*. It could legitimately have been disregarded in this context until the elimination of Article 71 on "monstrosities" from the *International Code of Botanical Nomenclature*. The type collection, *Drummond s.n.* (BM!, K!; photo of K specimen at DAO!), described as having much reduced flowers with greenish-yellow corollas, was obtained at Grand Rapids, Manitoba, in 1827. A similar specimen, *Scoggan 4407* (CAN), was found in the same area in 1948. I have seen such flowers on *G. virgata* late in the season, as the only flowers on a plant or on plants that also bore normal flowers, in a population of predominantly normal-flowered plants on the Bruce Peninsula. Their failure to develop fully appeared likely to be due to late bud formation and/or to stress from drought or other adverse growing conditions. In the case of *Gentiana ventricosa*, however, my examination of the type collection led me to suspect, as did Gray (1878), that it may merely comprise normal plants of *G. crinita* collected in bud rather than in full bloom. Thomas Drummond was at the type locality in mid-August 1827, relatively early in the flowering season for fringed gentians even at that latitude. Other specimens at BM, collected by John Richardson in present-day Canada but lacking locality data, were also identified as *G. ventricosa*, presumably by Grisebach. They likewise appear to be *G. crinita* with immature flowers.

Hybridization between *Gentianopsis crinita* (Froel.) Y.C. Ma s. lat., with a chromosome number of $2n$=78 (base number x=13), and *G. detonsa* (Rottbøll) Y.C. Ma s. lat., supposedly with $2n$=44 (base number x=11), has been suggested as a possible explanation for this abnormal flower development, but this now appears unlikely. No representatives of *G. detonsa* s. lat. are known to occur within several hundred km of Grand Rapids, Manitoba, nor have any plants of *Gentianopsis* in North America actually been found to have chromosomes in multiples of 11. It now seems likely that all have x=13, unless multiples of 11 occur in relatively distantly related western species. Reports of $2n$=44 for some of the North American subspecies of *G. detonsa* and for *G. thermalis* (Kuntze) H.H. Iltis (which is sometimes included in *G. detonsa*) have been based only on an early report of $2n$=44 for *G. detonsa* [subsp. *detonsa*] in Iceland, whereas all of the more recent counts for *G. detonsa*, including those for Icelandic plants, have been $2n$=78, the same number that has been reported for *G. crinita* and *G. virgata*.

Both *G. crinita*, represented by *Scoggan 4822* (CAN) and *4759* (CAN, GH!), and a subspecies of *G. virgata*, represented by *Scoggan 4854* (CAN, GH!), are known from Grand Rapids (Gillett 1957), but the abnormal flower development does not per se support a hypothesis of *G. crinita* x *G. virgata* hybrid origin. Although in general these species are morphologically distinct from each other and are more or less isolated ecologically, a few hybrid swarms are known, mostly in northern Ohio, in sites of recent disturbance (specimens I have so identified are at CLM). These hybrids have well-developed flowers. The relatively wide, lance-ovate cauline leaves of "*G. ventricosa*," as seen in the type collection and

as illustrated in Hooker's *Flora Boreali-Americana*, Atlas, pl. CLII, indicate that these specimens represent *G. crinita* s. str. rather than *G. virgata*. Therefore I do not feel that the name *Gentianopsis ventricosa* should be considered heterotypically synonymous with *G. virgata*.

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EUCOMMIA ULMOIDES (HARDY RUBBER-TREE; EUCOMMIACEAE) AS AN ESCAPE IN NORTH AMERICA

Michael A. Vincent
W.S. Turrell Herbarium, Department of Botany,
Miami University, Oxford, Ohio 45056 USA,
513. 529. 2755, VincenMA@MUOhio.edu

Eucommia ulmoides Oliver (Fig. 1) is the sole living member of the genus *Eucommia* Oliver and the family Eucommiaceae. This genus is thought to have been native to mountain forests in central and western China, in open forests and in valleys, at elevations of 200–2500 m (Ying et al. 1993). It was first brought to the attention of western botanists by Augustine Henry in 1886 (Forrest 1995), shortly after which it was described by Oliver (1890), and was introduced into cultivation in Europe in 1892 and the United States in 1896 (Forrest 1995; Poor 1997; Rehder 1947). The species was thought to be extinct in the wild, surviving only through cultivation (Mabberley 1997; Poor 1997; Sargent 1913), but native stands may still exist (Swink et al. 1978; Varossieau 1942). Fossil remains of the genus have been found in North America, Europe, and Asia, evidence that the genus was widespread in the Cenozoic and that its present-day distribution is relictual (Call & Dilcher 1997). It is called hardy rubber-tree in many sources, though Barker (1984) suggested that it be called "hardy gutta tree," "gutta-percha tree," or "Chinese threadtree."

Eucommia ulmoides is a tree to perhaps 12–20 m tall, with a spreading crown reaching about the same breadth. The single trunk has dark gray-brown bark that is ridged and furrowed. Trunks form ascending branches 1–2 m above the ground; young branchlets are shiny brown, and have septate pith, though this character may be difficult to see, since the pith is easily crushed. Buds are 5–7 mm long, sessile, ovoid, and pointed, with several overlapping chestnut brown scales; terminal buds are absent. Leaves are 8–20 cm long, alternate, simple, petiolate, exstipulate, elliptical to ovate, glabrous and glossy, with serrate margins; venation is pinnate; leaves are a deep dark green when young, becoming pale green to yellowish in autumn before leaf drop. When carefully torn and gently pulled apart, leaves show strands of latex (the gutta-percha for which the species is known). The stalked axillary flowers, which open as the leaves emerge, lack a perianth, and the plants are dioecious. Staminate flowers consist of 4–10 linear green anthers, on very short filaments, that open to release the bright yellow pollen. Pistillate flowers consist of a single bicarpellate, unilocular superior ovary with two pendulous ovules. The fruit is a flattened, elliptical samara 1.5–2 cm long that becomes dark brown at maturity, and contains 1 or 2 linear seeds. Flowering occurs in March or April, and fruits mature in September or October. There is a documented chromosome count for the species of $2n=34$ (Tanaka & Oginuma 1983).

The relationship of *Eucommia* to other extant taxa has been difficult to discern.

FIGURE 1. *Eucommia ulmoides*. Left: branch and leaves (*Vincent 10,442* [MU]); upper right: staminate flowers from a cultivated plant (*Vincent 5,805* [MU]); lower right: fruits from a cultivated plant (*Vincent 10,887* [MU]). The scale bar represents 1 cm for all images.

Oliver (1890) initially suggested placement of the genus in either the Ulmaceae or Euphorbiaceae, but only a few years later, he suggested placement of *Eucommia* in the Trochodendraceae (Oliver 1895). *Eucommia* was allied with the Hamamelidaceae (Hamamelidae, Hamamelidales) by Solereder (1899), but other authors (Harms 1930; Tippo 1940) placed it in Ulmaceae (Urticales, on the basis of flower morphology, fruit shape, leaf venation, and wood anatomy). It was segregated into its own family by van Tieghem (1900), a move that was supported by an extensive

analysis of the evidence by Varossieau (1942). Hutchinson (1967) placed the family in the Urticales. More recently, some authors have placed the genus in its own order, Eucommiales, on the basis of major differences, such as the absence of stipules, node anatomy, pollen wall traits, endosperm type, and the presence of a specialized latex (Cronquist 1988; Takhtajan 1981). Zhang et al. (1988) considered the family allied to Hamamelidales based on their study of the pollen. Thorne (1992) places the family in the Rosiidae, in order Cornales. Kubitzki (1993) states that its morphology and anatomy show a possible link between *Eucommia* and Cornales. Most recent DNA analyses suggest placement of the Eucommiaceae in Garryales (Bremer et al. 2001; Soltis et al. 2000).

The plant has been put to many uses, such as lumber, firewood, and a medicinal tonic (duzhong or tu-chung) made from the bark (Forrest 1995; Mabberley 1997; Sargent 1913). The tonic has been used in China for over 2000 years, purportedly to promote longevity, "nourish" the kidneys and liver, strengthen joints and the back, and prevent miscarriages (Anonymous 2001; Forrest 1995). Nakamura et al. (1997) report on antimutagenic activity of Tochu tea, made from *Eucommia ulmoides* leaves. Other scientists are testing the ability of extracts of leaves or stems of the species to inhibit bacterial growth (Jeon et al. 1998), suppress high blood pressure (Nakazawa et al. 1997), and inhibit some effects of aging (Li et al. 1998; Metori et al. 1997, 1998). The species contains a latex (gutta-percha) that is visible in a carefully-torn leaf blade (Coombes 1992). Watson (1903) thought the tree would prove useful as a source of rubber, though Rehder (1947) discounted its usefulness for commercial rubber production. The latex has been used in China for lining oil pipelines, insulating electrical lines, and filling teeth (Mabberley 1997).

Hardy rubber-tree is sometimes used as a street or lawn tree, and has been considered underutilized by some horticulturalists (Barker 1984; Dirr 1990, 1997; Gilman 1997; Poor 1997; Rehder 1947; Schnelle 1990). It is described as a vigorous and decorative plant (Coombes 1992) and an excellent shade tree of "dapper" outline when mature (Dirr 1990). It is drought-resistant (Gilman & Watson 1993), disease free, and easily propagated by seed or cuttings (Poor 1997). However, one study in Cleveland that lasted about 30 years resulted in replacement of hardy rubber-tree with other tree species, because the "overall effect was not particularly pleasing" (Todd et al. 1999). Flint (1983) states that while the species is free from insect and disease problems, it tends to produce vigorous "water sprouts" that may be a problem. *Eucommia ulmoides* is listed as hardy in USDA Zones 4–7 (Dirr, 1990, 1997; Poor 1997). It is said to be intolerant of poorly drained soil (Gilman 1997).

Plants of *Eucommia ulmoides* were recently found as escapes in Oxford, Butler County, Ohio, 15m and 20m from a pistillate tree planted on the Miami University campus. The sterile, immature saplings (up to 2 m tall) were growing in a fencerow with other weedy woody species, including *Acer platanoides* L. (Aceraceae), *Lonicera maackii* (Rupr.) Maxim. (Caprifoliaceae), and *Rhamnus cathartica* L. (Rhamnaceae). A voucher specimen (*Vincent 10,442*) has been deposited in herbarium MU, with duplicates at NA, MO, OS, and OSH. This record is the first report of the species (and the family) as an escape in Ohio and North America.

The discovery of *Eucommia ulmoides* as an escape is not necessarily an indication that the species will become invasive. In fact, the species is planted relatively infrequently, and since this is the first report of its escape in the more than 100 years since its introduction in the United States, it seems unlikely that it will become invasive. Hardy rubber-tree does not fit the profile of readily invasive species as described by Reichard & Hamilton (1997). Studies by Call & Dilcher (1997) of the aerodynamics of *Eucommia* fruits showed that they are dispersed in a downward spiral with an increasing lateral component. The fruits are relatively heavy and not as easily wind-blown as are samaras of other, more invasive woody plants, such as *Ulmus* species (Anonymous 2002; Sherman-Broyles et al. 1997). If more escapes of this species are to be found, it will likely be in the vicinity of pistillate trees near fence rows and woodlots.

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On the New York stage, there are routinely revivals of much-loved plays and musicals. What follows below is a kind of revival; just as theater-goers have rediscovered the delights of "Oklahoma!," the writer has re-discovered the fine biography of Charles Deam, 1865–1953. The book was most favorably reviewed by the late Howard Crum in *The Michigan Botanist*, 29(3): 87-88, the issue for May, 1990. Here is a fresh look. The publisher keeps the book in print, though only in hardcover, and what is currently available is apparently a later printing, not a new edition, dated July, 1994. The original paperback is widely available on the used-book market.

REVIEW

PLAIN OL' CHARLIE DEAM, PIONEER HOOSIER BOTANIST. Robert C. Kriebel. Purdue University Press, West Lafayette, IN., July 1994. $29.95, hardcover, at amazon.com. 183 pages.

Charlie Deam was, as described in the preface, an intense, irascible, opinionated, hilarious Hoosier original. The description is well supported by the biographical story that follows. Charles Clemon Dean was born in the closing days of the Civil War in Wells County, Indiana; that's near Bluffton. His upbringing was typical of the traditional country kid of the time which included hard farm work, fishing, a little church-going, and an occasional day off for squirrel hunting. He also loved books and had an insatiable desire for knowledge.

When he was 16, he survived a bout of typhoid fever but his mother did not and shortly after he acquired a step-mother who made it easy for him to leave home as soon as he was out of high school. He taught in a rural school for a bit and then went to Depauw University until he ran out of money two years later. As he said, " I ran out of money, so I quit. Then, too, it took too much time. I already knew more than they could teach me."

Fate stepped in and he began a job in a Bluffton drug store, learning the business as he tended the ice cream fountain. Over time and with hard work, which was a trait of Charlie's no matter what he was doing, he finally acquired his own drugstore and thereby a means of support which allowed him, in 1893, to marry Stella. When hard-working Charlie was advised by his doctor to "take life a little easier," he and Stella would take woodland walks where they gathered wildflowers and interesting medicinal plants. Well, that did it. Typically, Charlie couldn't just admire the plants and flowers but had to know everything about them. He learned to identify them, spell and pronounce their scientific names, map their ranges, learn about their anatomy and physiology, etc. Thus began his botanical education and his collection of Indiana plants.

Over the years, Charlie added to his herbarium every year, often in the thousands of specimens. For example, in 1922, between May and October he added 2,865 specimens which brought the grand total in his herbarium that year to 38,173. And this was still early in his collecting years. That number would exceed 73,300 by the time he departed for those ever-blooming fields in May, 1953 at the age of 88, just a month after Stella.

With his knowledge of plants he wrote a number of papers about them, which were presented at the Indiana Academy of Science, and several books, the first of which was "The Trees of Indiana" first published in 1912 as a 300+ page Bulletin of the State Board of Forestry. He was State forester at the time, splitting his time between an office in Indianapolis and his two drugstores in Bluffton. The book was written in his "spare time" using the knowledge he had gained in collecting the thousands of tree specimens in his field work.

The Flora of Indiana is his monumental work. A 1200 page volume, it consists of descriptions of more than 2000 species which he verified by consulting more than 84,000 herbarium specimens from 170 collectors, in addition to his own. It came to be viewed as a landmark in the botanical literature of middle America. It still is. It was reprinted in 1984, but now is no longer routinely available. Charlie Deam was a botanist's botanist. He exemplified the attitudes and goals which so many of us appreciate. His story is a joy to read.

—Donna Schumann
Kalamazoo, MI
616. 349. 2900

POST-EUROPEAN SETTLEMENT FOREST CHANGES IN OSCODA AND OGEMAW COUNTIES, MICHIGAN

Carolyn A. Copenheaver[1] and Marc D. Abrams (agl@psu.edu)

203 Forest Resources Laboratory, School of Forest Resources
The Pennsylvania State University, University Park 16802

ABSTRACT

Witness trees from Ogemaw and Oscoda counties were used to identify presettlement forest composition in order to compare how different historical land uses altered early settlement and present-day forests. Presettlement forests in Ogemaw County were dominated by *Tsuga canadensis* (17%), *Pinus banksiana* (13%), and *Fagus grandifolia* (12%). Oscoda County was dominated by *Pinus banksiana* (42%) and *Pinus resinosa* (16%). *Tsuga canadensis* was significantly ($P = 0.05$) associated with sandy loams in depressions; *Fagus grandifolia* was significantly associated with sandy loams on uplands; *Pinus banksiana* was significantly associated with sandy plains; and *Pinus resinosa* was significantly associated with sandy uplands. Both counties were logged of *Pinus strobus* and valuable hardwoods in the late 1800s. In the early 1900s, farms were established on the cutover hardwood sites. Temporary use of these logged sites for agriculture prevented successful regeneration of hardwoods. Thus, following agricultural declines in the 1930s, *Pinus banksiana* seedlings invaded these abandoned farmlands. Other cutover sites experienced repeated slash fires, which also favored the invasion of the fire-adapted *Pinus banksiana.* In contrast, pre-European settlement *Pinus banksiana* sites were not logged; however, these sites experienced fire suppression during the last 70 years and fire-intolerant early successional hardwoods have invaded these sites. This study demonstrated the strong influence of soils and topography on the distribution of pre-European settlement vegetation in northern lower Michigan, but post-European settlement species distribution has been more influenced by land use history.

INTRODUCTION

Original land surveys and other historical data serve as a base line from which to evaluate how post-European settlement land-use history has altered North American forests (Ahlgren & Ahlgren 1983; Foster et al. 1996; Russell 1997). European settlers introduced many new land uses when they settled in North America (Cronon 1983; Flader 1983; Whitney, 1994). Most vegetation was significantly changed as a result of introduced anthropogenic disturbances such as charcoal production, exotic species, fire suppression, firewood cutting, grazing, intensive agriculture, logging, maple syrup production, and slash fires (Siccama 1971; Dodge 1987; Abrams & Ruffner 1995; Mikan & Abrams 1995; Motzkin et al. 1996; Simard & Bouchard 1996; Cowell 1998). In areas where fewer Europeans settled, the landscape remained relatively similar to its pre-European settlement composition and structure (Kenoyer 1930; Donnelly & Murphy 1987; DeSalm 1994).

Two methods of land surveying were used in the United States: metes and

[1]Present address: 228C Cheatham Hall, Department of Forestry, Virginia Tech, Blacksburg, VA 24061 ccopenhe@vt.edu

bounds surveys and rectangular surveys. In general, the eastern states were surveyed with the metes and bounds system and the western and central states were surveyed with the rectangular system. In the metes and bounds system, witness trees were identified at irregular intervals across the landscape resulting in an unintentional, albeit highly biased, sampling of pre-European settlement forests (Bourdo 1956; Black & Abrams 2001). In 1785, the Continental Congress designated the rectangular survey method as the official survey method for all public lands. Surveyors using the rectangular survey method recorded the species and diameter of two to four trees at every intersection within a one-square mile grid system. In most surveys, two quarter-section trees (witness trees marked at the half-mile point between grid intersections) were also recorded. The stratification of this survey method reduced sampling location biases associated with the metes and bounds data; however, the risk of individual surveyor bias (selection of preferred species and diameter for witness trees, misidentification of species, and falsification of data) still existed (Bourdo 1956). The higher potential for biases associated with the metes and bounds surveys resulted in most early forest historians reconstructing maps of the pre-European settlement forests in areas that had been surveyed with the rectangular method (Sears 1925; Kenoyer 1933; Gordon 1940).

Michigan, which was surveyed with the rectangular system, was one of the earliest states where witness trees were used to understand historical forest composition (Livingston 1905; Kenoyer 1930). Many of the studies focused their analysis on constructing maps of pre-European settlement forest composition (Kenoyer 1933; Dick 1937; Kenoyer 1940; Kenoyer 1942; Merk 1951). Later studies combined the original land survey data with other data sets to explore relationships between original species composition and soils and topography (Fisher 1994; Barrett et al. 1995), Native American influences on pre-European settlement vegetation (Jones & Kapp 1972), the influence of the pre-European settlement disturbance regime on vegetation (Whitney 1986), and comparisons between current and pre-European settlement vegetation (Janke et al. 1978; Frelich 1995; Zhang et al. 2000).

In this study, we worked with original land surveys from Oscoda and Ogemaw counties in northern lower Michigan. The pre-European settlement forest composition of the two adjacent counties on the west (Crawford and Roscommon) has been thoroughly studied (Livingston 1905; Whitney 1986; Whitney 1987). Studying Oscoda and Ogemaw counties allowed us to contrast our findings with the previous studies to obtain a better understanding of some of the variability in the pre-European settlement forest. The Native American populations in Oscoda and Ogemaw counties were low and the impacts of native land use were minimal. Therefore, these study sites also provided a good baseline to examine the influence of introduced European land use on a relatively undisturbed forest (Twining 1983; Tanner 1986). Thus, our study objectives were to (1) identify presettlement forest composition and structure based on the Public Land Survey notes for Oscoda and Ogemaw counties, Michigan; (2) determine the importance of edaphic factors on presettlement forest composition; (3) compare presettlement, early settlement and present day forest transitions; (4) relate

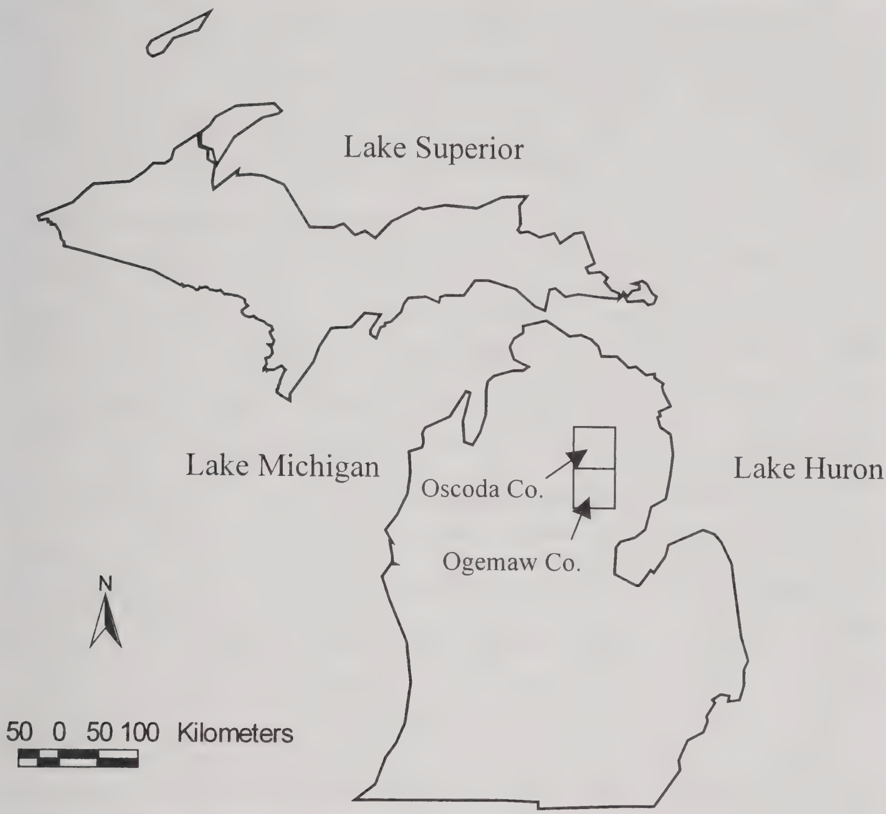

FIGURE 1. Oscoda and Ogemaw counties are located in northern lower Michigan.

land-use history to changes in forest composition; (5) compare the results from this study with findings from previously published studies.

THE STUDY AREA

Ogemaw and Oscoda counties (44°N, 84°W) are located in the northeastern portion of Michigan's lower peninsula (Figure 1). Ogemaw County contains 148,950 ha and Oscoda County has 147,629 ha. Their similarity in area allowed direct comparison of forest composition data between the two counties. The parent material in both counties is glacial till and glacial outwash deposited 10,000 years ago during the last glaciation (Veatch et al. 1931; Johnson 1990). Temperatures in Ogemaw County ranged from an average winter minimum of –11.2°C to an average summer maximum of 26.4°C. Temperatures in Oscoda County ranged from an average winter minimum of –11.8°C to an average summer maximum of 26.7°C. Annual precipitation was 75 cm in Ogemaw County and 69 cm in Oscoda County (http://www.ncdc.noaa.gov/ol/climate/climatedata.html).

Michigan remained largely uninhabited by Native Americans until the Hopewell culture (100 BC to AD 70). The Hopewell hunted, but did not have permanent settlements in Ogemaw and Oscoda counties (May & Brinks 1974). By the early 1600s, the Algonquians occupied most of the upper Great Lakes Region and four Algonquian earthworks, from temporary dwellings, existed in Ogemaw County along the AuSable River (Leach 1885; Hinsdale 1925; Dustin 1932; Dunbar & May 1995).

Ogemaw and Oscoda counties became part of the United States with the Treaty of Saginaw in 1836. Ogemaw County established its current boundaries in 1875 (Historical Committee 1975) and Oscoda County in 1881 (Nash 1979a). *Pinus strobus* L. and *Pinus resinosa* Aiton were harvested from both counties between 1870 and 1890. This logging period also indirectly influenced the growth of some of the lesser-valued trees as evidenced by Mayr's (1890) observation at the end of the 19^{th} Century that many *Pinus banksiana* Lambert (a low-value tree) were dying in northern lower Michigan because clearcutting of other species had altered the water table.

From 1890 to 1920, a second phase of timber cutting occurred with removal of hardwoods (*Acer, Betula, Fagus, Quercus* and *Ulmus*) and less desirable conifers (*Tsuga, Thuja, Picea* and *Abies*) (Randall 1979). Much of this timber was transported to mills on logging railroads (Nash 1979b; Parker 1983). After the second phase of cutting, large portions of both counties burned in numerous slash fires (Miller 1963; Historical Committee 1975). Some areas regenerated naturally, but the Civilian Conservation Corps planted pine and hardwood seedlings in both counties in the 1930s (Symon 1983).

Agriculture became a common land use in the 1890s, and eventually replaced logging as the dominant land use. Agriculture proved unsuccessful due to infertile, excessively well-drained soils. Therefore, most farms were abandoned in the early 1900s (Weaver 1942). The Great Depression brought bank failures and exacerbated agricultural hardships, causing abandonment of many of the remaining farms (Weaver 1942). Following the 1930s, the economy of these two counties was supported by production of *Populus* spp. and *Pinus banksiana* for pulpwood, a few small industries, and oil and gas wells in the West Branch Oil Field (Newman 1936; Blyth 1973, Michigan Dept. of Commerce 1985a;b). The close of the agricultural era also ushered in the tourist trade and the former saw log industry began to manufacture log cabin materials for new summer homes (Michigan Dept. of Conservation 1955). With the creation of the Huron National Forest in 1928, more than half of the privately owned land in Oscoda County was converted to public ownership and other large blocks of privately owned land were divided into small, vacation properties (Schallau 1965; Adams 1966).

METHODS

Presettlement forest composition and structure.

The Public Land Survey notes were available at the county courthouses. John Mullett and Benjamin Hall surveyed Ogemaw County from 1837 to 1846 and

identified 3,989 witness trees. John Randall, Edward Albertson, and Clarence O'Seeley surveyed Oscoda County from 1838 to 1840 and identified 4,033 witness trees. The survey instructions from the Surveyor General's Office indicated that witness tree selection was not biased by size or species as a result of survey instructions nor were the data manufactured by fraudulent surveyors because in two subsequent resurveys (1884 and 1908) the remains of many of the original witness trees were relocated (Clasen 1836; Lyon 1846).

To evaluate the presettlement species associations, the Cole/Hurlbert C_8 association coefficient was calculated from the paired witness tree data on species that occurred at a minimum of 20 locations in each of the two counties (Hurlbert 1969, Anderson & Anderson 1975). In the witness tree data, frequency varied by species and the Cole/Hurlbert C_8 association coefficient allowed valid comparisons across species of different frequencies because it was frequency independent. Survey points with only one witness tree were eliminated from the analysis. We constructed a dissimilarity matrix from the C_8 values and performed cluster analysis (Bastow et al. 1990) using multivariate analysis program, SAMPL (W. Myers, University Park, PA). SAMPL derived the first cluster formation by linking nearest neighbors; the program then evaluated the second closest neighbors for all species; this occasionally resulted in one species being identified within two of the initial clusters. If this occurred, these clusters were consolidated based on the linkage of second closest neighbors. After the linkage of second closest neighbors, the cluster analysis stopped.

Soils and topography

Contingency table analysis was used to assess the importance of edaphic factors on presettlement forest composition (Strahler 1978). We pooled the witness tree data from both counties for this analysis to allow inclusion of minor species without encountering problems associated with small predicted values (Steel et al. 1997). All witness trees were transcribed onto the USGS topographic quadrangles. Three topographic positions were identified: depressions, plains, and uplands. Depressions were areas lower than the average elevation and typically had swampy or boggy conditions. Plains were flat topographic areas and uplands were isolated ridges or rolling hills. A species by topographic position matrix was developed. A G-statistic was calculated for each species where $G^2 = 2 \sum$ (observed * ln (observed / expected)). These values were examined for significance at $\alpha = 0.05$. For species with significant relationships between species presence and topographic position, corrected standardized residuals were calculated by $E_{ij} / (V_{ij})$ ^ 0.5. Where

$$\text{Eij} = \frac{(\text{observed} - \text{expected})}{(\text{expected})\,\hat{}\,0.5}$$

and

$$\text{Vij} = \frac{((\text{observed column total} - \text{expected}) \times \text{observed row total})}{((\text{observed row total} - \text{expected}) \times \text{observed column total}).}$$

These corrected standardized residuals were plotted to identify relationships between species presence and topographic position.

Six of the USDA soil textures (based on particle size) were present in the two counties: loam, loamy sand, organic soils, sand, sandy loam and silt loam (Veatch et al. 1931; Johnson 1990). The witness trees were transcribed on the soil surveys and a species-soil matrix was created. G-statistics were calculated in the same manner as for topographic position and when significant relationships existed ($\alpha = 0.05$), the corrected standardized residuals were calculated.

Changes in forest composition and historical land use

Forest composition data were available from three time periods: the witness tree data from the public land survey (1837–1846); the Michigan Department of Conservation land economic survey maps (1923–1931); and the Michigan Department of Natural Resources forest cover type map (1990). Combining several historical records to track forest changes has risks because each data set had different surveyors, objectives, and sampling methods (McCune & Menges 1986). To minimize potential interpretation errors, all data sources had to be reduced to the level of the least informative data set. The witness trees from the public land survey created a point-intercept sampling grid of trees at section corners and quarter section posts (Muller-Dombois & Ellenberg 1974). Therefore, even though both later data sets had forest cover data available, we reduced those data sets to sampling points from the same locations as the witness trees. Thus, we created matrices of forest change from a point-intercept sampling of the same locations over three time periods.

To examine whether the distribution of logging railroads occurred equally in all forest associations, we performed a chi-square goodness-of-fit test on the ratio of railroad presence in each of the forest associations. The expected values were based on the frequency of each association in the witness tree data. The chi-square value was examined for significance at á = 0.05.

RESULTS AND DISCUSSION

Presettlement forest composition and structure

Witness trees were used to determine species frequency and diameter distribution within presettlement forests in Ogemaw and Oscoda counties (Table 1, Figure 2). Ogemaw County was dominated by *Tsuga canadensis* (L.) Carrière (17%), *Pinus banksiana* (13%), *Fagus grandifolia* Ehrh. (12%), *Pinus resinosa* (12%), and *Pinus strobus* (10%). Oscoda County was dominated by *Pinus banksiana* (42%) and *Pinus resinosa* (16%). Oscoda County's presettlement forest had more small diameter trees than Ogemaw County. Sixty percent of Ogemaw County's witness trees were over 20 cm in diameter, but only 44% of Oscoda County's witness trees were over 20 cm in diameter (Figure 2). The dominance of small-diameter trees and the high percentage of pines in Oscoda County (65% compared to 35% in Ogemaw County (Table 1)) indicate a more

TABLE 1. Relative frequency of species in the Public Land Survey data collected from 1836–1846 in Ogemaw and Oscoda counties, Michigan. The values in parentheses are the species rank for each county; tied species are indicated with an asterisk.

Species	Surveyor's names	Ogemaw County	Oscoda County
Abies balsamea	balsam, fir	1.5 (13)	0.9 (15)
Acer rubrum	maple	4.3 (8)	1.1 (14)
Acer saccharum	sugar, hard maple	4.4 (7)	1.6 (11)
Alnus incana	black alder	0.2 (21*)	0.0 (20)
Betula alleghaniensis	yellow birch	0.5 (19)	0.1 (19*)
Betula papyrifera	white birch	1.0 (17)	1.2 (13*)
Betula sp.	birch	1.6 (12)	2.3 (8)
Fagus grandifolia	beech	12.2 (3)	5.6 (5)
Fraxinus americana	white ash	0.2 (21*)	0.1 (19*)
Fraxinus nigra	black ash	3.4 (10)	0.2 (18*)
Larix laricina	tamarack	3.5 (9)	2.8 (7)
Ostrya virginiana	ironwood	0.3 (20*)	0.1 (19*)
Picea sp.	spruce	1.1 (16)	0.5 (16)
Pinus banksiana	spruce pine, pitch pine	13.3 (2)	42.4 (1)
Pinus resinosa	yellow pine	11.9 (4)	16.3 (2)
Pinus sp.	pine	0.1 (22*)	1.4 (12)
Pinus strobus	white pine	9.6 (5)	4.6 (6)
Populus sp.	aspen	2.0 (11)	7.0 (3)
Prunus serotina	black cherry	0.1 (22*)	0.0 (20)
Quercus alba	white oak	1.2 (15)	0.4 (17)
Quercus prinoides	dwarf oak	0.0 (23)	1.7 (10)
Quercus rubra	red oak	0.3 (20*)	0.1 (19*)
Quercus velutina	black oak	1.5 (14)	1.2 (13*)
Thuja occidentalis	cedar	7.2 (6)	2.2 (9)
Tilia americana	linden	0.9 (18*)	0.2 (18*)
Tsuga canadensis	hemlock	17.0 (1)	6.0 (4)
Ulmus americana	elm	0.9 (18*)	0.2 (18*)

frequent disturbance regime which resulted in a younger, *Pinus*-dominated forest compared to the *Fagus-Tsuga* dominated forests in Ogemaw County. One structural characteristic common to both counties was the presence of large diameter *Pinus resinosa* (in Ogemaw County 68% of the *Pinus resinosa* were over 37 cm and in Oscoda County 60% were over 37 cm).

The cluster analysis of the Cole/Hurlbert C_8 association coefficients divided the 22 species into three clusters or pre-European settlement forest communities. A community of xeric species contained: *Acer rubrum* L., *Pinus banksiana, Pinus resinosa, Populus* sp., *Quercus prinoides* Willd., and *Quercus velutina* Lam. (this species association will hereafter be referred to as the *Pinus banksiana-Pinus resinosa* association). A community of mesic to hydric species included: *Abies balsamea* (L.) Miller, *Acer saccharum, Betula alleghaniensis, Betula papyrifera, Fagus grandifolia, Fraxinus nigra, Larix laricina* (Duroi) K.Koch, *Picea* sp., *Thuja occidentalis* L., *Tilia americana, Tsuga canadensis,* and *Ulmus americana* (this association will hereafter be referred to as the *Tsuga canadensis-Fagus grandifolia* association). This cluster contained the most heterogeneous group of species because many species were grouped during the second linkage. The third community contained xeric to mesic species and included: *Pinus strobus* and *Quercus alba* L. (this association will hereafter be

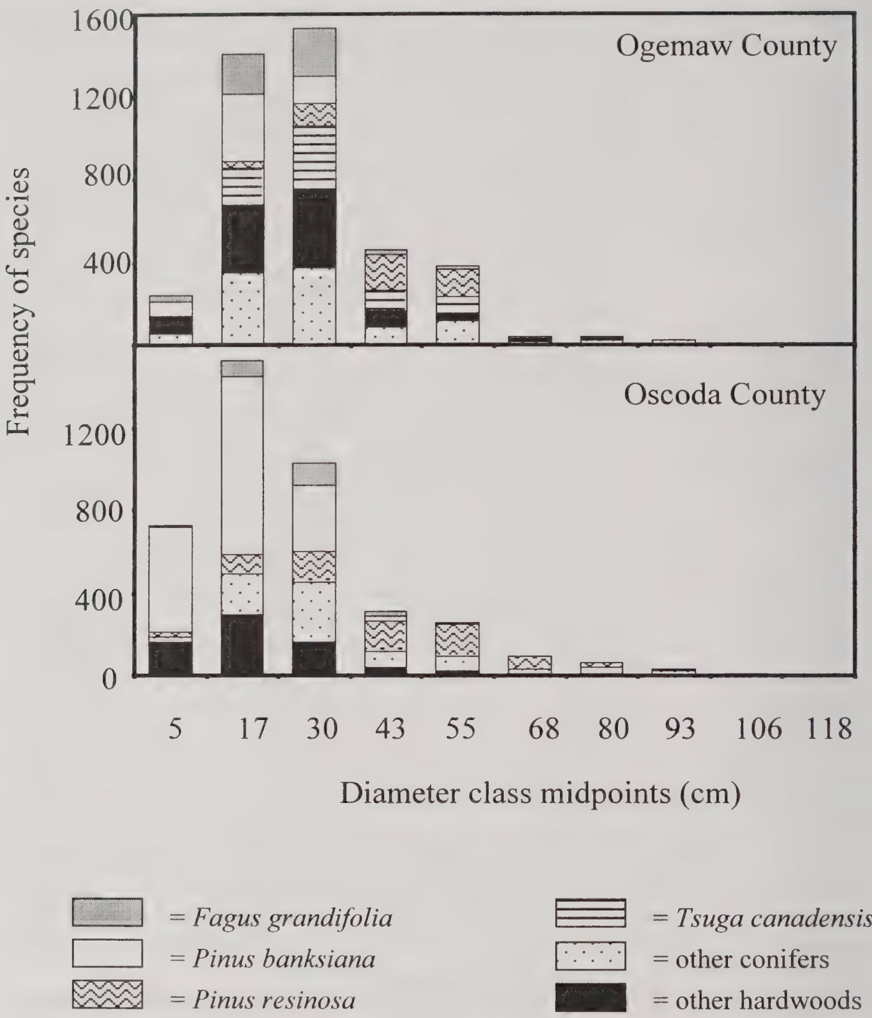

FIGURE 2. Diameter distributions for Ogemaw and Oscoda counties, Michigan based on witness tree data in Public Land Survey notes from the early 1800s. The category "other conifers" includes *Abies balsamea, Larix laricina, Picea* sp., *Pinus strobus* and *Thuja occidentalis*. Other hardwoods includes: *Acer rubrum, Acer saccharum, Alnus incana, Betula alleghaniensis, Betula papyrifera, Fraxinus americana, Fraxinus nigra, Ostrya virginiana, Populus* sp., *Prunus serotina, Tilia americana* and *Ulmus americana.*

referred to as the *Pinus strobus* association). Species composition in communities does not necessarily remain static through time (Gleason 1926; Abrams & Ruffner 1995; Abrams & McCay 1996). Therefore, it was important to identify the species associations contemporary with the sampling period. In Ogemaw and Oscoda counties, our cluster analysis showed that pre-European settlement species associations were very similar to modern associations. The combination

of cluster analysis and Cole/Hurlbert C_8 association coefficients appeared to be a valuable tool for evaluating historical community composition from paired witness tree data.

One common feature identified in many of the southern Michigan reconstructions of presettlement forest was the presence of prairie intrusions in the form of small grassy openings within a hardwood-dominated forest (Dick 1937; Brewer et al. 1984; Dodge 1987). The southern counties in Michigan were closer to the midwestern prairies and therefore, grass quickly invaded fire-caused openings. However, in Ogemaw and Oscoda counties, fire-caused openings were filled with the small-diameter, young *Pinus banksiana* (Figure 2). *Pinus banksiana* reaches its southern range limit at the middle of Michigan's lower peninsula; therefore, the post-fire niche filled by grasses in the southern part of the peninsula is filled by the fire-adapted *Pinus banksiana* in the northern portion of the peninsula.

Soils and topography

Soils and topography determined pre-European settlement species distribution in northern lower Michigan's forests. *Abies balsamea, Acer rubrum, Fraxinus nigra, Picea* sp., *Thuja occidentalis*, and *Tsuga canadensis* had significant ($\alpha = 0.05$) positive associations with depressions (Figure 3), although Whitney's (1986) work in the two adjacent counties identified *Acer rubrum* as associated with rolling extensive uplands rather than depressions. *Acer rubrum* has a bimodal distribution and grows well in hydric depressions and xeric uplands, but is outcompeted by *Acer saccharum* at mesic sites (Abrams 1998). Only by combining the results of this study with Whitney's (1986) was *Acer rubrum*'s bimodal distribution identified, thus indicating that larger sampling sizes were required to detect a non-normal distribution. *Pinus banksiana* and *Populus* sp. had significant positive associations with plains. *Acer saccharum, Fagus grandifolia, Pinus resinosa, Quercus alba, Quercus prinoides* and *Quercus velutina* had significant positive associations with uplands. A few species showed a significant positive association with two topographic positions (i.e., *Larix laricina* had significant positive associations with depressions and uplands), but most species were positively associated with only one topographic position (Figure 3).

Acer rubrum, Betula papyrifera, Fraxinus nigra, Pinus strobus and *Quercus veluntia* had significant positive associations with loamy soils (Figure 4). *Acer saccharum* and *Quercus alba* had significant positive associations with loamy sand. *Larix laricina,* and *Thuja occidentalis* had significant positive associations with organic soils. *Pinus banksiana, Pinus resinosa* and *Quercus prinoides* were significantly associated with sand. *Fagus grandifolia* and *Tsuga canadensis* were significantly associated with sandy loam. *Abies balsamea* and *Populus* sp. had significant positive associations with silt loam. Most species showed positive significant associations with several soil textures (i.e. *Acer saccharum* had significant positive associations with loam, loamy sand and sandy loam) however, one species, *Pinus banksiana,* was positively associated with only one soil category (sand). The species not included in the figures were either not significantly

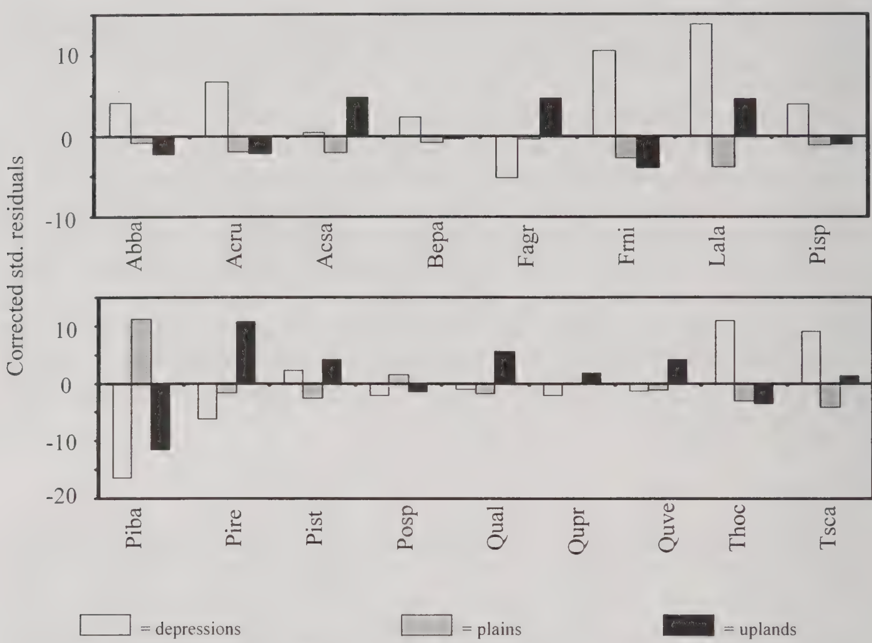

FIGURE 3. Significant (P = 0.05) relationships between witness trees and topographic position in Ogemaw and Oscoda counties, Michigan. A positive value indicates a positive association between that species and the topographic position. Species names are abbreviated as follows: Abba = *Abies balsamea*, Acru = *Acer rubrum*, Acsa = *Acer saccharum*, Bepa = *Betula papyrifera*, Fagr = *Fagus grandifolia*, Frni = *Fraxinus nigra*, Lala = *Larix laricina*, Piba = *Pinus banksiana*, Pire = *Pinus resinosa*, Pisp = *Picea* spp., Pist = *Pinus strobus*, Posp = *Populus* spp., Qual = *Quercus alba*, Qupr = *Quercus prinoides*, Quve = *Quercus velutina*, Thoc = *Thuja occidentalis*, and Tsca = *Tsuga canadensis*.

associated with soil or topographic categories or did not meet the assumptions for the G-statistic calculation due to small expected values (Steel et al., 1997).

Changes in forest composition and historical land use

After European settlement, both counties experienced a substantial reduction in *Tsuga canadensis-Fagus grandifolia* and *Pinus strobus* due to logging in these forest associations (Table 2; Hargreaves and Foehl 1964; Randall, 1979). Most of the harvested hardwoods and *Pinus strobus* were transported via railroads. Maps of logging railroads mirror the location of presettlement hardwoods, but railroads are mostly absent from areas dominated by *Pinus banksiana* (Figure 5; Nash 1979b). The distribution of logging railroads was not independent of presettlement forest association ($X^2 = 11.91$; d.f. = 2; á = 0.05). The *Tsuga canadensis-Fagus grandifolia* and *Pinus strobus* associations had a significantly higher proportion of logging railroads than the *Pinus banksiana-Pinus resinosa* association. In Ogemaw County, by 1923, only 6% of the presettlement *Tsuga canadensis—Fagus grandifolia* remained undisturbed. If the land had been

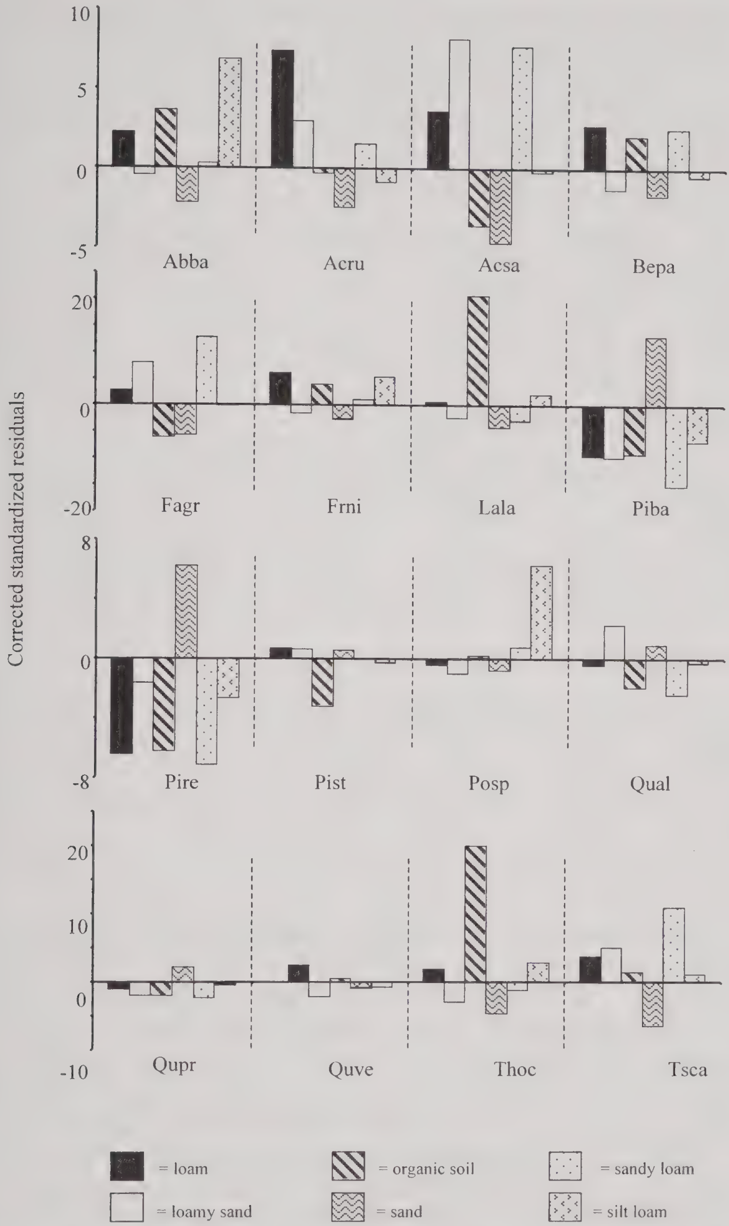

FIGURE 4. Significant (P = 0.05) corrected standardized residuals for witness tree and soil relationships. A positive value indicates a positive association between the species and soil category. A negative value indicates a negative association between the species and soil category. Species are abbreviated as follows: Abba = *Abies balsamea,* Acru = *Acer rubrum,* Acsa = *Acer saccharum*, Bepa = *Betula papyrifera*, Fagr = *Fagus grandifolia,* Frni = *Fraxinus nigra,* Lala = *Larix laricina,* Piba = *Pinus banksiana,* Pire = *Pinus resinosa,* Pist = *Pinus strobus,* Posp = *Populus* spp., Qual = *Quercus alba,* Qupr = *Quercus prinoides,* Quve = *Quercus velutina,* Thoc = *Thuja occidentalis,* and Tsca = *Tsuga canadensis.*

TABLE 2. This matrix shows the forest association changes that occurred in Ogemaw and Oscoda counties over three time periods. The rows show the percent change in each forest association over time with the forest associations abbreviated as follows: Piba-Pire = *Pinus banksiana-Pinus resinosa,* Tsca-Fagr = *Tsuga canadensis-Fagus grandifolia,* and Pist = *Pinus strobus.* The value in parentheses after the association name is the total number of sample points from the earlier period.

(A) Time periods: 1830 (left) to 1923 (top)

	Piba-Pire	Tsca-Fagr	Pist	non-forest	burned	total
Piba-Pire (1973)	73.1	2.8	0.1	23.4	0.6	100%
Tsca-Fagr (1379)	37.9	12.3	0.4	48.4	1.0	100%
Pist (279)	67.0	3.6	0.7	28.3	0.4	100%
non-forest (155)	47.1	5.2	0.6	45.2	1.9	100%
burned (40)	80.0	0.0	0.0	20.0	0.0	100%

(B) Time periods: 1830 (left) to 1990 (top)

	Piba-Pire	Tsca-Fagr	Pist	non-forest	burned	total
Piba-Pire (1973)	64.0	16.8	0.0	19.2	0.0	100%
Tsca-Fagr (1379)	32.1	31.3	0.0	36.6	0.0	100%
Pist (279)	45.5	35.5	0.0	19.0	0.0	100%
non-forest (155)	40.0	29.0	0.0	31.0	0.0	100%
burned (40)	87.5	2.5	0.0	10.0	0.0	100%

(C) Time periods: 1923 (left) to 1990 (top)

	Piba-Pire	Tsca-Fagr	Pist	non-forest	burned	total
Piba-Pire (2123)	57.3	25.5	0.0	17.2	0.0	100%
Tsca-Fagr (232)	45.7	34.5	0.0	19.8	0.0	100%
Pist (10)	80.0	10.0	0.0	10.0	0.0	100%
non-forest (1151)	39.1	18.8	0.0	42.1	0.0	100%
burned (25)	64.0	8.0	0.0	28.0	0.0	100%

abandoned immediately after harvesting hardwoods may have regenerated on the better sites; however, developers sold much of this cleared land to farmers. Troyer lists a total of 4229 ha of cut-over "stump lands" for sale in Oscoda County in 1915. Some of these cut-over areas were quite extensive, but most occurred on former hardwood or *Pinus strobus* lands. One typical property was described as "about five thousand acres of cut-over hardwood land in Elmer township." Although Ogemaw County experienced more extensive agricultural use than in Oscoda County, agricultural productivity in both counties declined in the 1930s. These largely unsuccessful attempts at agriculture destroyed the window of regeneration from seeds or stump sprouts left after the hardwood harvest. In addition to farming attempts, many cut-over lands experienced repeated slash fires which killed hardwood regeneration (Maybee, 1973; Kirkland, 1990). The only remaining seed source after agricultural abandonment and repeated slash fires was from the invasive xeric species left on the pine plains that had not been harvested. The absence of competition from mesic species allowed the early successional, fire-adapted pines to expand their range (Figure 5; Table 2). The fed-

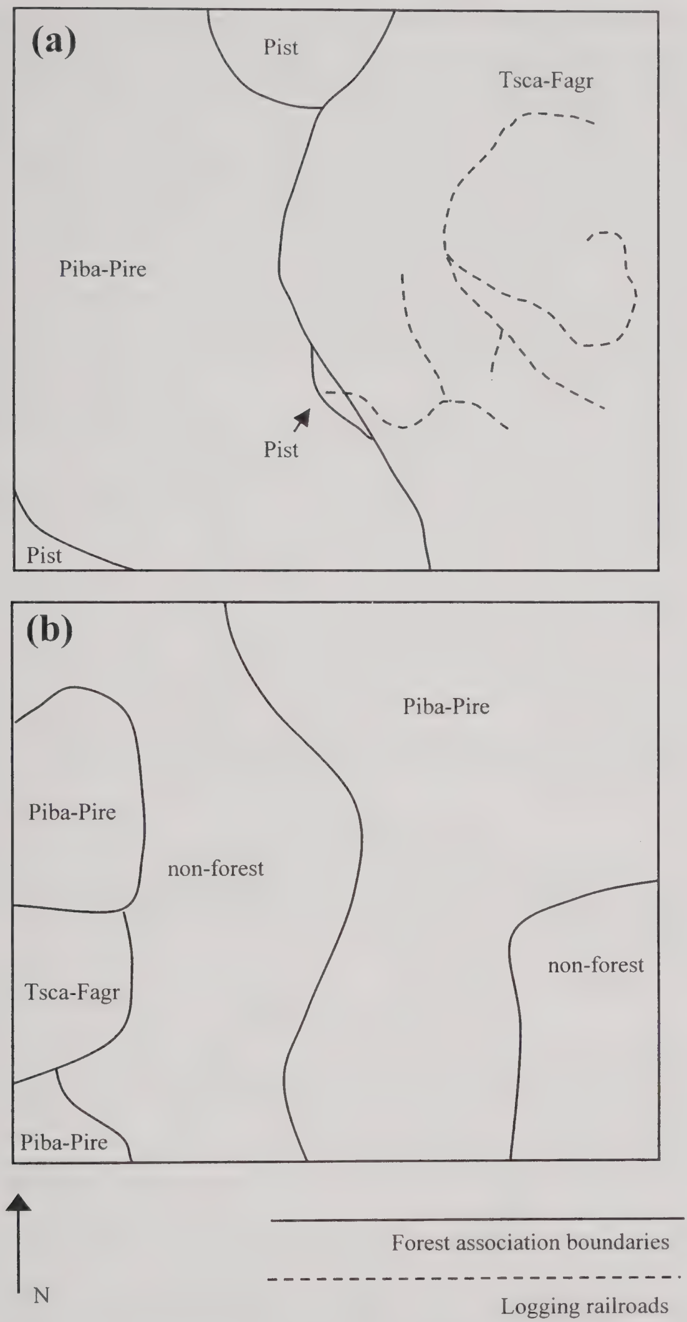

FIGURE 5. Forest changes in Township 27 North, Range 2 East in Oscoda County, Michigan. (a) presettlement (1838) forest associations with the location of early settlement railroads. (b) present-day (1990) forest associations.

eral and state reforestation of conifers on cut-over lands also contributed to the increase in the *Pinus banksiana–Pinus resinosa* association (Syman, 1983).

In an opposite trend from cut-over hardwood lands, the unlogged, pre-European settlement *Pinus banksiana–Pinus resinosa* forests experienced an increase in hardwoods and a decrease in *Pinus*. In Oscoda County, *Pinus banksiana* decreased by half (from 42% to 22%); *Pinus resinosa* decreased slightly (from 16% to 11%); while *Populus* spp. increased four-fold (from 7% to 29%) and *Quercus* spp. increased seven-fold (from 3% to 22%) (Table 1; Jakes, 1982). Fire suppression was responsible for this increase in hardwood species. Fire has always been an important disturbance agent in northern lower Michigan and has excluded hardwoods and favored conifers (Beal, 1888; Simard and Blank, 1982; Rouse, 1986). The original survey notes identify burned sections in 69% of the townships. The burned descriptions range from expansive township-sized fires to much smaller fires that only burned portions of stands (Mullett, 1838). One of the main reasons fire suppression was possible was the presence of the Civilian Conservation Corps (CCC) within these two counties. The CCC camps were specifically located on state and private land considered to be high fire hazards. The CCC fought forest fires, built fire towers, built roads to aid fire fighting in remote areas, and constructed landing fields for airplanes used for forest fire control work (Young, 1938). In northern lower Michigan, estimates of fire in *Pinus banksiana* forests decreased from an average return interval of 125 years during the presettlement period to 392 years during the fire suppression period (Whitney, 1987). Over a hundred years later, the consequences of fire suppression were evidenced in the increased dominance of hardwoods on lands formerly dominated by the *Pinus banksiana-Pinus resinosa* association.

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REVIEW

FLORA OF MAINE. A manual for identification of native and naturalized vascular plants of Maine. Arthur Haines and Thomas F. Vining. 1998. Paperback, 848 pp., ISBN 0-9664874-0-0. V. F. Thomas Co., P.O. Box 281, Bar Harbor, Maine 04069; $51 including shipping and handling, and they accept credit cards; info@vfthomas.com for e-mail orders. Shipped with 15 pages of additions and corrections, these dated 26 April 2002.

For nearly five years, this has been a kind of ghost title to me. I knew it was out there, but it was just too darned much trouble to get my hands on it. For the longest time, it wasn't known at amazon.com, where just about everybody begins; it is listed there now, but "out of stock." So now its easily obtainable; I asked for an autographed copy, and darned if the two authors didn't sign the title page! That's no more than standard good manners from folks in Maine, but still . . . .

The book is based on the herbarium holdings at the University of Maine, Orono, and the herbaria of the University of New Hampshire and Harvard University. The authors don't make a big to-do about it, but it is clear they insist on proper vouchers, and they exclude unvouchered materials from their coverage. They make the point on p. 8 that reports of *Actinidia arguta* and *Aristolochia macrophylla* are unvouchered, but then on page 10 it says these two (and many others) have been added to Maine's flora based on the existence of a voucher specimen. Well, we cannot have it both ways, but it is not terribly important, given that the two species are only local escapes from cultivation.

The sequence of families is roughly Cronquistian; the genera within each family are simply alphabetical.

The keys are conventional and quite artificial. The species descriptions are very brief, but longer ones can be had in any of a dozen other books that cover New England. The status of each species in Maine is emphasized, with extralimital ranges also given, and they give common names. As an Appendix II, the authors put in a key to genera for use with vegetative, non-emergent, aquatic plant material. That could turn out to be most useful, and far outside Maine, too.

There are no illustrations, save for a cover illustration of a sprig of willow, *Salix arctophila*, rendered by the first author, Arthur Haines. This is explained on [unnumbered] page 2. But the cover illustration is initialed, m.m., in usual artist's fashion. The credit for the illustration can be left as one of the great unsolved mysteries in Maine botanical history, which is otherwise covered succinctly on p. 7.

What the book needs is an outline map that shows all the counties of Maine. That would have been really nice on Cover 2 or Cover 3, or even in both places. A work like this merits a happy future, and maybe in the next printing they could sneak in an outline map.

—Neil A. Harriman
Biology Department
University of Wisconsin-Oshkosh
Oshkosh, Wisconsin 54901 USA
harriman@uwosh.edu

NOTEWORTHY COLLECTION

MICHIGAN

Heracleum mantegazzianum Somm. & Levier. (Apiaceae). Giant Cow Parsnip, Hogweed

Previous knowledge. This federally listed Noxious Weed (USDA-APHIS-PPQ 2000) is a native of the Caucasus region of Asia and was probably first brought to North America as a garden plant because of its striking size. Since at least the late 1940s, it has escaped from gardens and has been found along roads and streams in several states and provinces. Hyypio and Cope (1982) noted it was grown in Highland Park near Rochester, New York in 1917; escaped populations were known in 24 counties in western New York by 1982. Morton (1978) mapped it from 19 sites in southern Ontario. Case and Beaman (1992) described *H. mantegazzianum* being found in a field in Ingham County, Michigan in 1991. Elsewhere in the eastern United States it has been reported from Maine, Maryland, Pennsylvania (Hyypio & Cope 1982), and in 2001 from several sites in Connecticut and Massachusetts (Small 2002). It has been known since the 1960s in the Pacific Northwest, with collections known from Oregon, Washington, and British Columbia (Hyypio & Cope 1982, Rice et al. 2002).

Significance. The collections cited below appear to be the first records of the occurrence of *Heracleum mantegazzianum* in the Upper Peninsula of Michigan. In addition to the two collected populations, Mr. Zylinski (pers. comm.) noted there were additional plants about a mile from the Lowell Avenue site, suggesting its occurrence in the Ironwood area is more than just a casual introduction. The closest population I am aware of is on Manitoulin Island, Ontario, where it has been known since the early 1980s (Morton & Venn 1984). Given the large numbers of seeds that are produced, it seems very likely that it could be found in other areas around Ironwood, and quite possibly in neighboring Wisconsin. Since it is a Federal Noxious Weed, additional localities should be sought and, besides reporting them as new floristic finds, local USDA authorities should be contacted since containment and eradication efforts, e.g., English et al.'s (1999) description of 1998 efforts near Erie, PA, are required under the Federal statutes.

Diagnostic characters. The massive size of the plants is the most obvious feature; stems reaching two to possibly 4–5 m in height, large ternately-compound leaves with incised segments, and umbels reaching 50 cm in diameter and having up to 150 rays. The stems are blotched with purple, each "blotch" containing stiff bristles which can easily break off and cause skin irritation. Extreme caution should be used in handling the plant since the sap contains a chemical which can cause phytophotodermatitis; when the sap contacts moist skin, painful blistering can occur. In addition, if that area is then exposed to sunlight, the skin is darkened and sometimes permanently scarred (Hyypio & Cope 1982, Morton 1978).

The fruits resemble those of other species of *Heracleum* known in our region, but are larger and have wider resin canals (as illustrated in Morton 1978).

GOGEBIC CO.: in shade of roadside trees, corner of Oak St. & Scott Ave, Ironwood, NW ¼, NW ¼, Sec. 27, T47N, R47W, 6 August 2002, *I. Shackleford 539* (MICH); E side of lot, NE corner of Lowell Ave. & E. Gogebic St., NW ¼. Sec, 22, T47N, R47W, 17 September 2002, *J. Zylinski s.n.* (MICH, UMBS, WIS).

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—Richard K. Rabeler
University of Michigan Herbarium
3600 Varsity Dr
Ann Arbor MI 48108-2287 USA
rabeler@umich.edu

CONTENTS

On the cover: *Clumps of eastern white pine* (Pinus strobus) *in the understory of a black oak* (Quercus velutina) *and white oak* (Quercus alba) *forest in Oak Openings Preserve, northwestern Ohio. Photograph by Scott R. Abella, 22 March 2001.*